New technologies drive the future of automotive coatings

Interview
Mr Paritosh Pradhan
Managing Director, Jaguar Surface Coating Equipments

Technical Feature
Data-driven pitting evolution prediction for corrosion-resistant alloys by time-series analysis

New Products & Processes | **Industry News** | **Case Study** | **Company Profile**

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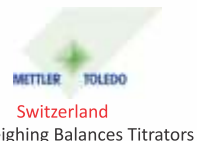75 microns
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STD/ADV BODY

COATING THICKNESS ON NON-METALS
200B POLYMER COATING ON WOOD, PLASTIC, 200C COATINGS ON CONCRETE, FIBERGLASS, 200D VERY THICK POLYMERS.

SURFACE PROFILE
SPG OS SPG CS/TS/S
SPG - Integral Probe
S - Cabled Probe
OS - Cabled Probe for Convex Surfaces
CS - Cabled Probe for Textured Coatings
TS - Cabled Probe for Concrete Profile

SHORE HARDNESS
PRBSHD A PRBSHD D
A - HARDNESS OF RUBBER
D - HARDNESS OF PLASTIC

ULTRASONIC THICKNESS
UTG C UTG M UTG P
C - Corrosion Probe
M - Multiple Echo Probe Thru Coat
P - Precision Probe

DEW POINT (Td,RH,T)
DPM S DPM A DPM D
S- Integral probe with cabled Surface Temperature Sensor
A- Intergral Probe with Wind Speed Sensor
D- Cabled Probe with 1/2" NPT Threads

SOLUBLE SALT TESTER (BRESLE PATCH)
ADHESIVE PATCH LATEX ADHESIVE PATCH POSIPATCH

COATING THICKNESS ON METALS (F & FN)
Cabled Regular Micro 0° Probe Micro 45° Probe 90°Telescopic Probe

TESTEX TAPE READER
PRBRTRH PRBRTR3D
RTRH1 - Measures peak height (HL)
RTR 3D - measuring common 2D/3D profile

INFRARED THERMOMETER

BARCOL HARDNESS TESTER

NEW

AUTO. PULL OFF DOLLY ADHESION TESTER AT-A / AT-M

HOLIDAY DETECTOR HHD (STICK TYPE)

PINHOLE DETECTOR LPD

DFT GAUGE POSITEST COMBO(FN) & F

PC POWDER CHECKER (FOR UNCURED COATING THICKNESS)

Concrete Moisture Meter (CMM)

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COATINGS AND ANTI CORROSION
ENGINEERING REVIEW

COVER PHOTO: 123RF

COATINGS AND ANTI CORROSION
ENGINEERING REVIEW

From the Editor-in-Chief...

The combined death toll due to the massive earthquake that hit Turkey and Syria in February, now officially stands at 47,244. Our sincere and heartfelt condolences and prayers to those countries as well as the grieving families. February also marks the one year into the Ukraine-Russia conflict which does not show any sign of waning soon. The Russia-Ukraine war disrupted the chances of global economic recovery from the COVID-19 pandemic, at least in the short term. The war between these two countries has led to economic sanctions on multiple countries, a surge in commodity prices, and supply chain disruptions, affecting many markets across the globe.

Yet, adjustments are made and life goes on. According to a report by the Business Research Company, the automotive coatings market is expected to grow to $24.55 billion in 2026 at a CAGR of 7.2%. The Asia Pacific region is growing due to the rapid industrialization in the region during recent years. Nations such as South Korea, India, China, Japan, and Malaysia are the main contributors to the evolution of this regional market. Incidentally, India became the world's third-largest automobile market in 2022 surpassing Japan as vehicle sales rose. The market progress is influenced by factors such as rising urbanization, altering lifestyles, growing buying power of the population, and an increasing level of consumer awareness for the maintenance and protection of vehicles.

In this issue, we talk about the market scenario in automotive coatings as also the new developments in coatings and specially designed coating for EVs which are opening new avenues for the automotive paints and coatings market.

This issue also features some interesting interviews, company profiles, case studies, plus all our regular features and columns to keep you updated with the latest in the coatings and corrosion mitigation industry. Happy reading!!!

Jolly Lonappan
Editor-in-Chief

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CORROSION, ABRASION & CHEMICAL ATTACKS destroy crores of rupees worth equipment every year. Worldwide research shows that nearly 70%-80% equipment failures are purely due to their surface erosion. The need for effective preventive maintenance therefore is imperative.

The time has arrived for ceramics to finally take centre stage. Jyoti Ceramic Industries has specially developed ceramic filled polymer based coating compounds, "**Aluma Coat®-BR**" brushable / sprayable and "**Aluma Coat®-TW**" trowelable.

Aluma Coat® - TW

A trowelable, easy to apply protective coating, comprising of sintered sapphire-hard ceramic micro beads, doped in polymer resins designed to resist corrosion, abrasion and moderate surface impact. It gives a rough textured surface finish and can withstand maximum service temperature up to 150^0C / 302^0F.

Aluma Coat® - BR

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Aluma Coat® - TW

Mineral Crusher Coated with Aluma Coat - TW

Inner Base of Dust Collector Coated with Aluma Coat - TW

Aluma Coat® - BR

Motor Shaft Coated with Aluma Coat - BR

Butterfly Valve Coated with Aluma Coat - BR

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Jotun launches SteelMaster 1200HPE - a high-performance epoxy intumescent coating providing up to 120 minutes protection against cellulosic fires

SteelMaster 1200HPE is a high-performance epoxy intumescent coating providing up to 120 minutes protection against cellulosic fire for infrastructure buildings, notes a press release from Jotun (jotun.com).

SteelMaster 1200HPE is a high-performance epoxy intumescent coating providing up to 120 minutes protection against cellulosic fire for infrastructure buildings.

As the latest contribution to the company's SteelMaster range, SteelMaster 1200HPE is developed to meet the demands for cellulosic fire protection applied offsite. Engineered to protect structural steel of public spaces, including airports, hotels, train stations, school buildings, stadiums and malls, this high build, 100% solids epoxy product combines fire protection with weather resistance up to C5 environments.

According to John Warner, Jotun's Global Category Manager for Cellulosic Fire Protection, SteelMaster 1200HPE represents a milestone for the company. "Our objective was to create a product for greater level of fire performance with the added protection and robust properties to withstand a wider range of the elements, whether that be extreme weather or impact protection.

This is the ideal intumescent product for applying off site, allowing for faster construction phase. It helps our customers save time and reduce project costs as multiple coats can be applied in a single shift, so turnaround times and constructability are dramatically improved," he says. "Due to extensive development, testing and verification, SteelMaster 1200HPE achieved excellent results with up to 2 hours fire protection."

As a long-term member of the Association for Specialist Fire Protection (ASFP), who represents and supports the activity of the fire industry in relation to all forms of 'built-in' fire protection, Jotun has extensive experience in intumescent coatings. The new SteelMaster 1200HPE compliments Jotun's range of SteelMaster products, enabling the company to strengthen its position within thin film intumescent market, both on site and off site.

SteelMaster 1200HPE is tested and approved in accordance to BS476 under Certifire scheme, an independent third-party certification scheme internationally recognised for ensuring the quality, performance and traceability of fire protection products. It is now also tested and approved in accordance to EN 13381-8, carries an European Technical

New additive TEGO® Powder Aid D01 improves powder coating formulations in many ways

Evonik´s Coating Additives Business Line (coating-additives.com) has developed a new, multifunctional polymer additive for powder coating formulations: TEGO® Powder Aid D01 makes the formulation easier to disperse during extrusion by promoting pigment wetting and effectively reducing melt viscosity, notes a press release from the company.

The lower melt viscosity also leads to better degassing, which aids flow and leveling as the formulation cures and prevents pinholes in the coating. Thus, the new additive optimizes gloss development and ensures better DOI (Distinctness of Image) on the coating surface.

Another plus point of TEGO® Powder Aid D01 is its particularly versatile applicability in formulations with inorganic fillers and pigments, along with organic pigments including carbon black. "Our new product thus offers a wide range of benefits for formulators who desire one multifunctional additive for various powder coating systems," says Maximilian Morin, head of the Industrial & Transportation Coatings market segment. "TEGO®

Powder Aid D01 generates a large effect in small amounts and acts as a synergist with other additives."

Powder coatings containing TEGO® Powder Aid D01 also show comparable resistance to weathering, making this additive suitable for use in exterior applications.

TEGO® Powder Aid D01 also plays to its strengths in HAA curing systems for powder coatings with water being formed as a by-product. "The challenge during crosslinking is, that the water needs to escape from the system. This can result in pinholes or small craters in the film," explains Bernhard Resch, Scientist in Market Segment Industrial & Transportation Coatings.

To avoid this, the low melt viscosity is particularly important: homogenization of the ingredients and leveling of the surface is improved. "TEGO® Powder Aid D01 prevents pinholes by increasing the degassing threshold and enables the application of thicker coating films," says Resch.

Powder coatings containing TEGO® Powder Aid D01 also show comparable resistance to weathering, making this additive suitable for use in exterior applications.

Assessment (ETA) and is CE-marked.

SteelMaster 1200HPE is compatible with a range of Jotun primers and topcoats as

Jotun's goal is not only to provide the market with superior individual products, but to offer comprehensive system solutions.

Trenton offers three Wax-Tape® brand anticorrosion wrap systems.

High-quality, easy-to-apply wraps that protect irregularly shaped fittings and require minimal surface preparation.
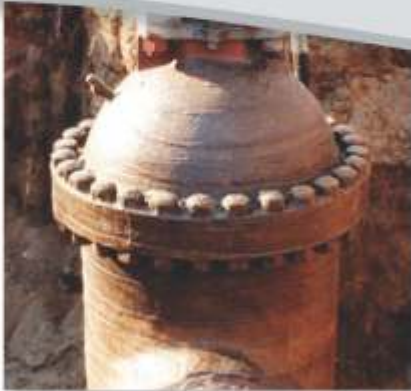
Belowground applications

Wax-Tape® #1

Anticorrosion Wrap:
A very durable wrap that uses a thick, non-stitch bonded synthetic fabric and has no clay fillers, so it stays conformed to irregular profiles. The wrap requires no abrasion blasting, can be backfilled immediately and is compatible with cathodic protection.

Aboveground and belowground applications

Wax-Tape® #2

Self-Firming Anticorrosion Wrap:
A unique, microcystalline-wax-saturated wrap that slowly firms up to provide excellent aboveground and belowground protection. Comes in a variety of colors and usually requires no outerwrap.

High-temperature applications

Wax-Tape® HT-3000

High-Temperature Anticorrosion Wrap:
Designed for operating temperatures up to 230°F (110°C), Wax-Tape® HT-3000 wrap can be used on high-temperature oil and gas piping, on compressor station discharge piping, beneath thermal insulation and in high ambient temperature conditions.

Only Trenton offers Wax-Tape® brand anticorrosion wrap systems, with primers, wraps and outerwraps.

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AkzoNobel India launches new Dulux Weathershield Powerflexx, the *Gharka* Champion

AkzoNobel, the maker of Dulux paints in India, has launched the upgraded next generation, ultra-premium offering in its trusted Weathershield range of exterior paints – the new Dulux Weathershield Powerflexx.

The new Weathershield Powerflexx comes powered with the company's innovative Triple Defence Technology which is powered by the advanced PU modified acrylic. This results in an improved brand promise of longer lasting 12-year assured

homes, consumers today are increasingly demanding high-quality exterior paints that can protect and keep their homes looking beautiful for longer. Enhanced with the break-through Triple Defence Technology, Dulux Weathershield Powerflexx now provides even longer-lasting protection for homes, and greater peace-of-mind to homeowners with an extended 12-year protection assurance, making it the ultimate *Gharka* Champion," said Rajiv Rajgopal, Managing Director, AkzoNobel India.

PHOTO: AKZONOBEL

Dulux Weathershield Powerflexx provides even longer-lasting protection for homes with an extended 12-year protection assurance.

protection of home exteriors against all-weather conditions, notes a press release from the company. Now, homeowners can now rest assured that whatever be the case - extreme heat, extreme rainfall, impact of UV rays, surface cracks, dirt or dust – the new Dulux Weathershield Powerflexx will keep their home exteriors looking as good as new for more than a decade.

"Given the harsh impact of climate and weather on

The Triple Defence Technology provides superior crack bridging, superior weather resistance and superior water resistance properties to home exteriors.

The advanced PU modified acrylic technology addresses homeowners' long drawn battle with surface cracks, thanks to the paint's tough yet stretchable film composition. Additionally, the product which is positioned as a champion product "*Gharka*

SATAjet K 1800 spray mix – new ultra-high pressure coating

SATA (sata.com) has introduced the new SATAjet K 1800 spray mix, an innovative new product in the field of ultra-high pressure coating.

With the "spray mix technology," the paint material is applied at ultra-high pressure, creating a pre-formed airless spray fan. Through the air cap, compressed air is fed to this airless spray fan, which helps to shape it and enables an even droplet distribution. The result is a homogeneous material application for highest surface quality.

The new lightweight gun in this spray gun class with its well-balanced gun body combines an optimized ergonomic design with a finely-tuned nozzle range and with the innovative 'clampLock' paint needle system: The ergonomic design in combination with the low trigger force of only 24 ηm enables fatigue-free working even during longer coating sessions.

Thanks to its low weight, the SATAjet K 1800 spray mix is perfect for continuous and time-intensive coating processes. The innovative, two-part clampLock paint needle system enables an

easier maintenance.

The SATAjet K 1800 is an excellent tool for a wide range of applications in various sectors – from the woodworking and

PHOTO: SATA

The new SATA spray mix spray gun is perfectly suited for both classic craftmanship as well as for industrial applications.

automotive industry to machinery, steelwork and also shipbuilding and container construction.

The new SATA spray mix spray gun is perfectly suited for both classic craftmanship as well as for industrial applications, e.g. for the coating of large surfaces and a wide range of components. Thanks to the various adjustment options and the finely tuned nozzle range, it is the perfect choice if it comes to high profitability, high area output and high finishing quality.

One can also retrofit a swivel joint for the material connection as well as for the air connection. This reduces the twisting of the connected hoses and makes the painting process easier.

Champion" also protects homes against dampness, algae, fungus, alkali build up and paint peel, thus keeping homes looking pristine for longer periods.

The all-new Dulux

Weathershield Powerflexx is now available for purchase at authorised Dulux retail outlets across the country. Visit www.dulux.in for more product information and colour inspiration.

Heubach launches Hostatint™ SA for luxurious wood finishes

The Heubach Group (heubach.com), a leading provider of comprehensive color solutions has launched their latest advanced pigment preparations for luxurious wood finishes. An optimal solution for tinting natural wood stains and oils that are derived from oils such as linseed. As such Hostatint SA preparations do not require special labelling, making them perfect to replace traditional dyes, notes a press release from the company.

Visualization of attainable effect in clear lacquer at 1% and 5% dosage of Hostatint™ SA Transoxide Yellow 2R, Transoxide Red B and Black N on anigre verneer.

With low viscosity, advanced sedimentation behavior, high tinting strength and consistent quality, they are easy to handle and restrict migration into waterborne or solvent borne topcoats. "Unlike any other material, natural wood can create a warm and beautiful atmosphere. It is extremely versatile and has been described as 'the new concrete,' used for everything from new building structures and façade cladding to green space fencing and interior decoration. Hostatint SA helps to maintain, preserve and enhance this common building material with your color of choice," said

Alexander Wörndle, Global Technical Marketing Coatings at Heubach.

In addition to this new product line, Heubach offers further pigment preparations lines for wood coatings – from traditional to contemporary shades. The recently re-formulated Hostatint™ UV 100 product range is the next generation of high-performance colorants for UV cured wood coatings. This new version is especially designed for industrial coatings and wood finishes and has been engineered without the inclusion of Hexandioldiacrylate (HDDA); it allows for compliance with requirements of major furniture and consumer goods producers.

Hostafine®, based on non-ionic dispersing and wetting agents and glycol, is designed for water-based wood treatments and dye replacement offering superior fastness and outstanding transparency for furniture and flooring while the water-based Colanyl 100 offers a huge color range ideal for furniture.

The new Licosperse™ pigment preparations for sustainable wood coatings, polishes, and other oil-or wax-based products were launched in 2021. The portfolio comprises brilliant shades from traditional to eye-catching, is made without

New pump generation from Dürr with contactless changeover valves

The newly launched EcoPump2 VP from Durr (durr.com) requires less maintenance and increases process reliability, notes a press communique from the company. The EcoPump2 VP is designed for various media typically found in industry and can be used in many fields such as mechanical engineering, metal working and woodworking, or the furniture industry.

contactless changeover valves used to regulate the air motor changeover guarantee higher process reliability. Using quick-exhaust valves cuts changeover times, reduces pulsations, and increases performance.

With five different versions of the EcoPump2 VP covering a pressure range from 22 to 306 bar, the pump is suitable for applying paints, high-

Dürr's latest pump generation cuts maintenance times and increases process reliability.

The new pump only needs one seal for the majority of applications, which is also much quicker and easier to change than on the predecessor model. The fluid parts can be disconnected from the air motor with conventional tools via a quick coupling. The new air motor can be operated without any oil. This significantly reduces the maintenance required, including in comparison with the competition. A further benefit is that the

viscosity materials, and adhesives to furniture, steel constructions, and many more materials. It can also handle acidic hardeners commonly used in the 2K process in the North American market without any difficulty.

The first feedback from customers has been consistently positive. The pump is quieter, it pulsates less, and takes less time to clean than the predecessor model.

the use of heavy metals and resin free, non-toxic and non-flammable. Additionally, the

ready-to-use blends help to save time and money in the coloration process.

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CRISIL Rating : SME 1 'Highest'

WACKER presents new silicone additive for silicate-based interior coatings

Munich-based WACKER Group (wacker.com) has introduced a new silicone additive for formulating silicate paints and brush-on plasters for interiors. This product, which is available as an aqueous emulsion under the name SILRES® BS 338, facilitates processing of the coating materials, increases their storage stability and enhances the properties of the applied coating. Wall paints and brush-on plasters produced with the silicone additive have the same breathability as before, but yield a hydrophobic, water-repellent finish that is only slightly absorbent. This greatly extends the range of options for manufacturers to tailor their silicate paints to market requirements, notes a press release from the company.

SILRES® BS 338 is a new silicone additive for interior silicate paints and plasters. Coatings modified with this additive are water-repellent, breathable and easy to apply.

SILRES® BS 338 complements WACKER's portfolio of additives for interior coatings. Unlike conventional silicone additives, the new product can cope with the high alkalinity of coating materials that contain a water glass as binder, such as silicate paints and silicate plasters. Wall coatings modified with SILRES® BS 338 are notable for their high storage stability.

The active ingredient in SILRES® BS 338 is a reactive polysiloxane. During setting, this forms a solid, durable bond with the surfaces of the filler and pigment particles in the coating materials. The resulting effects in the coating are permanent.

Thanks to its low surface tension, which is a characteristic property of silicones, the new additive improves the wetting properties of the coating material and lowers its viscosity. These two effects ensure that the coating material flows well during application. This makes it much easier to achieve level, uniform and streak-free results than was previously possible with silicate paints and plasters.

Silicones are typically hydrophobic and this is also true of SILRES® BS 338: coatings formulated with the additive are water-repellent. As a result, water droplets do not penetrate the surface, but roll off instead. In addition, the new silicone additive significantly reduces capillary water absorption and thus the absorbency of the coating as well. A silicate paint containing SILRES® BS 338 can therefore also be used in damp interior rooms.

The hydrophobicity and reduced absorbency are also noticeable during application. Since the first coat already confers a certain amount of water repellency on the substrate, the second coat is absorbed less and so remains wet for longer. This gives the user more time to make corrections. As a result, silicate paints and brush-on plasters are much easier to apply.

SILRES® BS 338 is extremely effective. All its effects are achieved at application rates of 1 to 3 percent, without causing undesirable side effects. Water vapor in masonry is still able to diffuse through the coating modified with SILRES® BS 338. The coating remains breathable.

Silicate paints and plasters are mineral coating materials. As they are aqueous, water glass-based systems, they are solvent-free and odorless. They are free of biocides and therefore ideal for painting interiors used by people who, for example, may suffer from allergies.

Automatic spray specimens' preparation workstation from Biuged

Biuged's BGD 370 Automatic Spray Specimens Preparation Workstation is a fully automatic workstation integrating automatic panel taking, automatic spraying and automatic drying. This workstation adopts cooperative robot, with spraying and drying functions, and can automatically and quickly prepare standard size specimens for testing, notes a write-up from Aadarsh Technologies (aadarshtech.com), their agents in India.

The BGD 370 Automatic Spray Specimens Preparation Workstation.

Amongst its various features, the workstation has a portable robot hand with high degree of automation, integrating automatic panel taking, automatic spraying and automatic drying and comes with a treatment device for spraying waste gas; automatic water channel and water curtain, dry and wet treatment at the same time.

The test panel has two clamping and are optional. Two 30mm diameter vacuum suckers are used during feeding, which can compensate the error of inconsistent height of test panel. Air claw clamping mode is adopted during unloading.

The Graco 24P993 spray gun with a nozzle diameter of 1.00mm is used for spraying. The spraying range can be adjusted by pressure, the atomization, the spraying and the feeding pressure range is 0-0.7MPa. The pressure can be automatically adjusted, and the control of the coating flow and the automatic control of the spraying pattern can be realized.

A pressure feeding device is used for coating and solvent, and comes with an automatic color change valve switching device. After spraying, it can be switched to solvent pipeline to clean, and finally switched to air pipeline to clean the residual solvent.

Equipped with a 2KW baking room, the maximum baking temperature can reach 150°C. The workstation is equipped with active exhaust and filtration function, in which the water curtain adopts submerged pump for water circulation. A 1.1KW three-phase AC motor with wind wheel is used for the air exhaust.

Multi-functional coating test instruments operate like "Swiss army knives"

Coating measurement equipment that performs like a "Swiss army knife" with multi-functional testing capabilities allow greater flexibility and productivity

With greater flexibility than limited traditional equipment, modern analytical instruments can ensure reliable coating performance by measuring critical characteristics like friction, peel, wear, and scratch resistance.

Industrial coatings applied to substrates like metal, plastic, glass, and composite protect various products from corrosion and damage to extend lifespan. Commercial coatings are also routinely applied to wood, metal and concrete structures to protect against mechanical, chemical, and environmental degradation while improving aesthetics. To ensure quality, manufacturers that utilize or formulate coatings rely on various methods of testing to determine resistance to friction, peel, wear, and scratches.

Without the necessary adhesive strength or durability, it is possible for a coating to bubble, flake, peel, or otherwise fail prematurely. Depending on the application, this can cause costly warranty issues as well as safety issues that can compromise the manufacturer's reputation and market share.

As an example, for several years a popular minivan struggled with paint blistering and bubbling in the heat, direct sun, and exposure to road salt in northern regions.

"Paint and primer would start to flake off some vehicles in a matter of just a few months, leading to rust spots and an undesirable finish. The auto manufacturer could have avoided damage to their reputation and financial loss from warranty claims with more thorough coating testing using the proper measurement equipment," says John Bogart, Managing Director of Kett US (kett.com), a manufacturer of a full range of testing instruments for adhesion, peel, and wear measurement.

PHOTOS: KETT US

Multi-functional testing capabilities allow greater flexibility and productivity.

To create reliable coatings or products that utilize them, engineers and quality assurance teams require reliable test instruments to verify that the necessary properties and industry standards are met, particularly for high-value or high-volume applications.

Although desktop and inline process analyzers are available, the challenge is that conventional coating test equipment typically offers a limited range of functions. Consequently, multiple instruments are often required. There are also other issues with traditional testing methods that make them inconsistent, laborious, and time-consuming.

As a result, some industry suppliers now provide a wide range of coating measurement equipment that performs like a "Swiss army knife" with multi-functional testing capabilities that allow greater flexibility and productivity. These desktop, online, and inline testing solutions are cost-effective analytical tools that can quickly determine a wide range of critical coating properties.

All-in-one desktop units

When various coating properties need to be tested, a desktop all-in-one unit like Kett's 14FW offers a significant amount of flexibility in a single machine with assorted jig attachments for specific tests. The device tests and measures multiple coating properties including friction, wear, peel, and scratch resistance.

The all-in-one unit provides exceptional flexibility to test coatings. By changing the jig attachment, the contact mode in friction and wear testing can be modified, and scratch intensity and peeling resistance tests can be performed. By presetting the speed of table movement, stroke length, and stroke count, the tester can provide testing under various conditions.

The unit can also measure scratch resistance. This is expressed based on the size of the scratch made by a conical scratch test pin while a predetermined vertical load is applied. A pencil scratch intensity test can also be performed.

The online testing solutions, like the BSR1700, are cost-effective analytical tools that can quickly determine a wide range of critical coating properties.

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NIR devices can be used to analyze moisture, film thickness, and coat weight, which can simplify the process for users.

Measurement is instant, the instrument eliminates the need to take samples to a laboratory and put production on hold.

analyzers utilize Near-infrared Reflectance (NIR) to provide accurate measurement of coatings without sampling, physical contact, or degradation. These units are available in desktop, online and inline models.

"With NIR, the surface of the coating, whether solid or liquid, is measured and light is absorbed by the chemical components. The detected absorbance is converted into component values," explains Bogart.

According to Bogart, conventional testing equipment utilizes substantial "force" that can damage the substrate material so ten tests or more may need to be conducted and averaged.

Since the H14FW unit utilizes much less force, it is more subtle and can be used to compare coatings on various substrates or items that are challenging to coat.

"The unit can detect very slight nuances in coating formulation batches. This allows manufacturers to confidently make critical coating decisions involving considerable capital, knowing they are making the best choice and proceeding correctly," says Bogart.

Continuous coating testing

The industry has developed benchtop instruments that enable the real-time testing of changes in frictional resistance due to wear when this is required. As an example, Kett's H40 Friction and Wear Tester uses a balance arm that crosses the feed table at right angles in forward and backward motions to measure frictional forces with very high accuracy.

The unit, which is equipped with a load converter containing a probe integrated into a holder, continuously measures changes in frictional resistance due to wear. The stroke count at which a coating peels, or its surface condition changes, is determined from an increase or decrease in the frictional resistance of the balance arm as it moves back and forth.

For greater precision, manufacturers can set the stroke length of the reciprocating balance arm from 1 to 100mm and automatically stop it when the desired travel distance is reached. The frictional resistance between the coating and the balance arm can be measured very precisely, from 0 to 9.8N.

Quality assurance technicians can use a variety of measurement jigs including those for point contact measurement (i.e. scratch test pin and ball indenter), plane contact (i.e. flat indenter), and line contact (i.e. blade holder).

With optional software, various measurements from static friction coefficient measurement to wear measurement can also be performed.

Although coatings are generally measured dry, testing a wet coating is possible with an addition that enables heating a sample to maintain the coating in liquid form.

Measuring coating thickness

To ensure consistent quality, OEMs also need to determine that a coating is evenly applied at the appropriate thickness.

"Applying too little of a coating risks poor product protection and aesthetics, and applying too much wastes money," says Bogart.

To simplify quality control, instant gauges like Kett's model LZ990 allow users to measure coating thickness with a simple, non-destructive test. As a quality check that can improve product consistency with great precision, the device displays thickness in either mils (.001 inch) or microns (.001mm) to the thousandth decimal place.

Inline composition analyzers

In high-value applications, manufacturers may also want to analyze the composition of specialized coatings. Advanced composition

NIR devices can also be used to analyze moisture, film thickness, and coat weight, which can simplify the process for users by allowing them to measure multiple properties with just one instrument and software.

Since measurement is instant, the instrument eliminates the need to take samples to a laboratory and put production on hold. With pinpoint accuracy, any employee can achieve consistent test results with minimal risk of error, allowing specialized technical staff to focus on other areas of the manufacturing process.
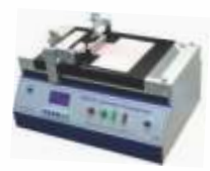
Ensuring essential coating properties are achieved is vital to performance in a wide range applications and products, so effective measurement is crucial to maintain quality. Manufacturers that take advantage of the most accurate instruments to measure all necessary coating characteristics can assure product quality, as well as protect the company's brand and reputation.

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IITD: Upskilling manpower across the construction industry

IITD launches skill development and entrepreneurship development program for waterproofing, repairs and building maintenance in Goa

Despite the enormous amount of knowledge in the domain, waterproofing is still a challenge. Due to the variety of materials and methods available, specifiers, applicators and supervisors are left clueless about material selection and application techniques. "We found there are lots of site personnel who do not have any formal training or even any education," said Er Sunny Surlaker, Director, The Institute For International Talent Development [IITD]. "We thought it would be a good idea if we could come up with something that would be of help to such people. Looking at the gap in the Skilling of Usage of Modern Materials and Techniques, IITD was conceptualized by Mr Samir Surlaker and Late K. P. Pradeep of Master Builder Magazine. That's how, we along with a few other like-minded people set up our training and skill development

centre, here in Goa."

The program is a joint initiative with the Construction Industry Development Council [CIDC] to offer a nationally recognized Certification of Competency. CIDC, an apex body in the construction industry, was setup with the Planning Commission / Niti Aayog and works to develop the Indian Construction Industry and raise its quality levels. One of CIDC's main initiatives, is training manpower across various levels in the construction industry.

The certification programs were developed under the guidance of Dr P. R. Swarup, Director General, CIDC keeping in mind the need to recognize and certify the skills of waterproofing professionals, to bridge the gap between demand and supply of skilled personnel. "The main objective of the program is to help participants' upskill or launch start-ups in

One of the Institute's main initiatives is training manpower across various levels in the construction industry.

waterproofing and maintenance of civil engineering assets," said Surlaker.

The basic Recognition of Prior Learning (RPL) certification program recognizes and verifies the experience of skilled workmen in waterproofing. It is meant for site supervisors and skilled workers who have been working in this area for over two years. This certification and testing program is a huge step in this direction.

After this, the professional can upskill with Level-II and Level-III programs. The Level III Program is a 3-Day Program on Waterproofing Systems for Durable Buildings and will introduce participants to a proven 5-Step Waterproofing Concept that includes admixtures and repairs. The program content includes principles of waterproofing, new and remedial; the 5-step waterproofing method; concrete / plaster improve-

ment; repair mortars; injection grouting and crack treatment; joint treatment; waterproof barrier coatings; drainage (mortars / tiling); estimation and costing; and application demonstrations. It will cover principles of material selection, their properties and application methodologies for new or old structures. "It's a combination, of classroom training, demonstrations, and practical," said Surlaker.

The learning objectives would be: identifying waterproofing challenges of the structure, rectifying the base, treating cracks and joints and selecting and applying waterproofing systems. The concepts are applicable to buildings, but can be extended to infrastructure as well. Basements, roofs, bathrooms, podiums, tanks, swimming pools and wet areas, masonry are some of the areas that will be covered.

This course is ideal for site

The program is a combination of classroom training, demonstrations, and practicals.

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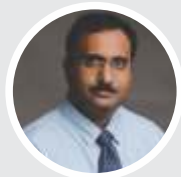
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Based on the course content, IITD also invites "international experts" for conducting training on specialized topics.

The IITD training center located at the Kundaim Industrial Estate, Goa.

supervisors / RPL Level I certificate holders; engineers, waterproofing entrepreneurs / applicators; site execution and planning engineers; engineering students, stakeholders in waterproofing industry; new entrants to construction chemical industry; consultants and engineers, where they get to understand various waterproofing materials; learn about detailing and work steps; understand consumption, coverage and costing; understand material selection for various problems; besides getting a nationally recognised certification from CIDC; preference in governmental projects; and networking with industry professionals.

The highlight of the program will be awarding a nationally recognised joint CIDC-IITD certification of competency provided to the participants, based on the level of participation and a written test. This certification will place the attendees in CIDC's national database, recognise their qualifications, improve their skills, and their employability. This certificate is valid for 1 to 2 years. "Just like in the United States, the Middle East and many other

countries, these certifications will soon become mandatory in tenders of known private and public organizations such as CPWD, PWD, MES, etc., emphasized Surlaker. "The provisions in the latest version General Conditions of Contract (GCC) of CPWD mentions that no less than 25 percent of the total number of workers skilled and semi-skilled working on the project must be skill tested and certified against earlier provision of 20 percent. For example, these revised requirements are enforced in the PQ document and NIT of the New Parliament Building of Central Vista Project – CPWD. Other government and private organizations are also adopting these revised requirements. As a waterproofing contracting company, this certification enhances your eligibility for qualifying for major government and private projects."

IITD is headquartered in Mumbai, while their training centre is located in the Kundaim Industrial Estate, Goa. Launched in 2016, IITD conducted specialty training courses for applicators. The Joint Training and Certification Programs with CIDC were

launched in 2022. "We had our first joint CIDC-IITD Training, Testing and Certification course in August 2022, and we are planning to have both Certification Programs and Training Programs at regular intervals," said Surlaker. With its wide area of expertise, network of CIDC approved trainers across India, strong industry ties, collaboration with the best professionals and companies helps IITD, carve a niche as one of the most sought after technical training institutes. Based on the course content offered, IITD also invites "international experts" for conducting trainings on specialised topics such as injection grouting technologies for waterproofing and soil stabilization, etc. This helps to secure wider appreciation of the interests of construction business by the government, industry and peer groups in society and helps solve challenges of the future.

The participation fees for the event includes course materials, demo materials and certification fees. To reach a large number of personnel, the fees are very affordable and modest. Each batch will

accommodate around 50 participants.

Apart from Training and Certification Activities, IITD also identifies talented individuals and does placements to high level positions in civil engineering and especially in construction chemical industry. IITD also contributes as "Knowledge Partner" for national and international technical conferences and seminars. They have been associated with IBMS/CWPRS/CEAI/ICI etc. as Knowledge Partners.

The faculty includes Er Sunny Surlaker with over 15 years of experience; Er Paulo Tsingos an international expert geotechnical engineer and veteran in injection technologies from F. Willich, Germany with over 30 years' experience; Mr Prasad Bhobe with over 15 years' experience; Mr Shounak Vaigankar with over 5 years' experience; Mr Sujay Surlaker with over 10 years' experience; and Mr Robert D'Souza with over 25 years' experience.

"In future, the plan is to expand with newer programs according to need and as we grow," said Er Surlaker.

Contact: iitd.edu@gmail.com

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Jaguar Surface Coating Equipments: specializing in special paint application systems

Mr Paritosh Pradhan, Managing Director, Jaguar Surface Coating Equipments, in a chat with C&ACER about the company, its products, and plans for growth in the future

Pune-headquartered Jaguar Surface Coating Equipments is an ISO 9001 – 2018 certified and CE certified company, professionally engaged in designing and manufacturing of airless spray painting equipment, automatic spray painting systems, plural component sprayer, paint circulation systems, paint transfer pumps and systems, dispensing equipment and systems and various fluid handling systems. They also offer electric airless sprayers, diaphragm pumps, paint booths, high pressure paint hoses, pneumatic paint agitator, pressure feed containers, air assisted guns and other accessories. Mr Paritosh Pradhan, Managing Director, Jaguar Surface Coating Equipments, in a chat with C&ACER about the company, its products, and plans for growth in the future.

What are the products you manufacture related to coatings / paint and corrosion mitigation?

Basically, we at Jaguar Surface Coatings Equipments, manufacture a wide range of pneumatically operated airless spray painting machines, electrical airless spray painting machines, customized pipe coating systems – internal and external, paint mixing systems, spray guns, paint circulation systems, and special purpose coating systems for different applications.

Pneumatically operated airless spray painting systems are used in places where high viscous, as well as low viscous coatings have to be sprayed. Generally higher ratio pumps are used to spray high viscous coatings like 100% volume solids, means more than 50 - 60 percent volume solids, which can be used for solvent less coatings, low solvent coatings, and which are used generally in corrosion preventive coating applications.

Electrically operated airless machines are used in industries as well as the architectural sector like painting of buildings.

Another specialty of ours is the internal/external pipe coating systems. Basically these systems are used to coat the insides as well as the outside of pipes to prevent corrosion. These can be used with various types of paints like food grade paints, or industrial paints for different types of applications.

The plural component hot airless spray machine.

PHOTO: JAGUAR SURFACE COATING EQUIPMENTS

Mr Paritosh Pradhan, Managing Director, Jaguar Surface Coating Equipments.

Accessories like different types of spray guns, paint circulation systems, etc., are also manufactured for different types of coatings, e.g. to coat finished products like automotive components, automotive bodies….

We also manufacture special purpose systems like the barrel coating system to coat different types of barrels, e.g. food grade barrels, grease barrels, etc. A special system is required if you need to coat the barrel both inside and outside.

What is the company's USP vis a vis your competitors?

The first principle is 'we compete with ourselves.' Next, the special design of our products which are user friendly as well as maintenance friendly, as well as our unique warranty systems automatically attracts the

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▸ High viscosity coatings
▸ Solvent less coatings
▸ Epoxy paints & mastics
▸ Polyurethane coatings
▸ Zinc base coatings
▸ Coltar epoxy & glassflex epoxy

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Various applications by airless spray machines.

customers. Importantly, we have an education program for our customers through literature, manuals, as well as videos. We also provide both online as well as onsite training programs. Onsite training is provided to the customer according to the specific application. The training includes how to operate the machine, how to maintain the system – both preventive and breakdown, and these we provide on a regular ongoing basis.

How do you market your products in India and for exports?

With a pan-India 22-strong dealer network or 'channel partners' as we treat them, we cover the entire country, and they have been with us for a

The airless spray gun models 2F and Nextera

long time. We have a 20-strong and confident marketing team that is constantly doing direct and online promotions. Our efficient after-sales service team has been the reason for regular repeat orders. We are also constantly training our dealers so they are up to date with knowledge about our products which helps them to serve the customers better. Besides, we also have contact training programs with contractors and applicators. This helps them to understand the product and the ease of using it and gives us a very good word-of-mouth publicity.

What are the new developments in the field of application equipment?

Nowadays, everyone wants

cost reduction, both in the cost of application as well as that of capital equipment. Not only our industry, but across the board, this is the trend. So, we too are developing these types of products which will save on the costs, both in terms of the raw material like paint, as well as the time saved in doing a particular job.

What are the new products you have launched recently, or will be launching in the near future?

Our latest is the electrically operated airless spray painting equipment that can be used in industrial, corrosion prevention, and architectural painting applications. About a month ago, we launched a new electrical equipment for putty spraying i.e. high viscous material. Generally electrical spray painting equipment are used for architectural painting with low viscous, water-based paints. We are looking for a good market in these new lines also.

Any expansion plans?

We have expansion plans in other parts of the globe, especially Europe and Australia. Primary talks are on and now we are reaching the

formal stage.

Where do you rank within this industry in India?

In India, we are the first Indian manufacturer of high pressure, electrically operated airless spray painting systems, and globally I would say, we could be in the top 10.

What are the challenges the industry faces?

We can sell a product, but to operate the equipment, you need a skilled person. If there are no skilled applicators available to operate the equipment, then we need to give them the required training. Training is the most important part of our machine. If you have a trained applicator, the application will be in a better form. This is the basic challenge we face, the fact that there are not enough skilled or trained applicators.

What is your manufacturing setup like?

We have four manufacturing units – two in Pune and two in Shrirampur (Ahmednagar). The first unit in Pune is located in Bhosari. Here we have our corporate office, and our design center. Our second unit also in Pune is dedicated to manufacturing activity and also houses our 'project design center.'

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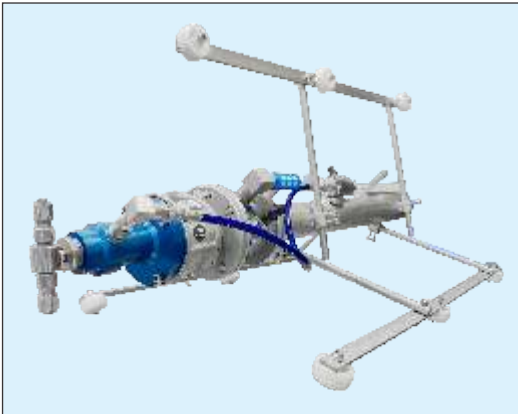
An internal pipe coating attachment.

The first R&D team focuses mainly on product development. They constantly seek feedback from customers, users, applicators and upgrade the products or introduce newer versions or models accordingly. The second R&D team designs systems for special purposes according to customer's application needs. We cannot mix the two. Product development is something different and systems designing is totally something else.

The third unit is located in Shrirampur where we do different types of special processing and include activity like heat treatments, chrome plating, hard chrome plating, different types of plating processes, different types of welding processes, etc. Our fourth unit has 85,000 sq ft of area where we have assembly lines on which we manufacture and assemble different types of products. We also have a product testing line where each and every product is tested after assembly. Also, we have a large store area and the packaging unit set up from where fully packed products are dispatched.

Where do you see your company, say five or ten years down the line?

Globally, our aim is to be in the top five and within India, we want to be the leading company in this line. We are a company having good professional as well as ethical approach with our customers, and our suppliers who are our channel partners who we consider as a part of our family or team.

Can you share a brief history about the company and how it has grown over the years?

Jaguar Surface Coating Equipments started manufacturing activities in 2003. At first we had a moderate setup where we manufactured small airless spray painting equipment, pressure pots, tanks etc. After that in 2007, we entered into bigger equipment like industrial airless spray painting equipment and systems and projects. At the same time, we also started supplying our equipment to government organizations like PSUs, Indian Railways, Navy while expanding our manufacturing set up in Bhosari. In 2009, we started exporting our products as well as our systems and started manufacturing total turnkey projects for painting systems. In 2011, we started our second manufacturing unit in Bhosari, where we started a dedicated machining center in which we had different types of CNC machines, special purpose machines through which we enhanced our production capacity as well as quality.

In 2013, we inaugurated our third unit in Shrirampur which was dedicated for special processes like hard chroming, heat treatment, and to carry out different painting processes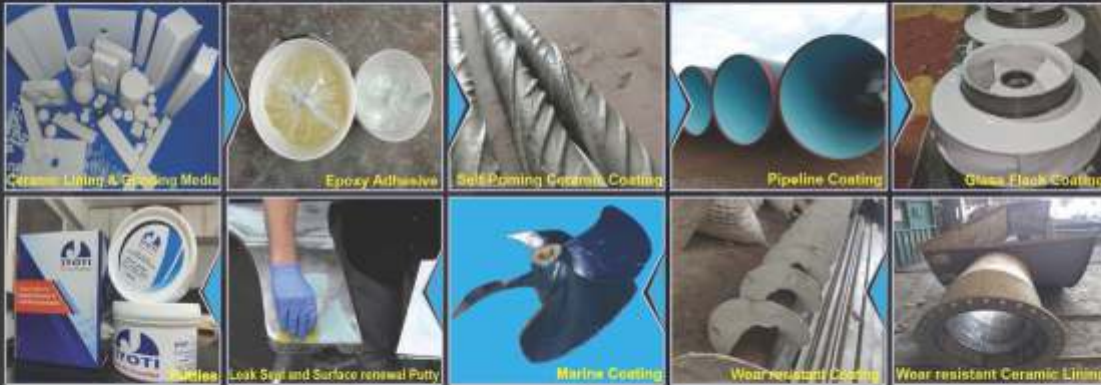, etc. Yes, you can get these processes done from vendors. But this setup enabled us to enhance and maintain quality as also ensure timely deliveries.

2017 saw us entering into electrically operated airless painting systems. It was a good time for these electrical systems as there were many industrial and residential projects coming up in a big way with big requirements for painting systems. At that time, we started our fourth unit, also in Shrirampur with as I said before 85,000 sq ft in area with assembly lines, testing, storage, and packaging areas. This unit helped us to upscale and increase productivity as well as maintain consistent quality. This was a milestone for our company at that particular time. With this, we were now able to compete with Chinese manufacturers and at the same time match the quality of European products.

The next couple of years, our aim is to introduce a do-it-yourself (DIY) range that will make a 'painter in each and every home.' Everyone can own a small painting equipment at home and can try their hand at conveniently painting any small object, say a small piece of furniture or decorative item.

New technologies drive the future of automotive coatings

The new developments in coatings and specially designed coatings for EVs are opening up new avenues for the automotive paints and coatings market

The oft-quoted statement of Mr Henry Ford in 1908: "The customer can get the Model T painted in any color he wants, so long as it's black!" sounds humorous today. But Ford was serious when he said it. Ford thought that black car paint was the only practical automotive paint for the Model T, as it was a coating both durable and cheap. In fact, the black car paint was not 'automotive' paint at all, but just the existing paint technology available at that point in time: a paint based on natural linseed oil resin as the binder. Oil resins cure through oxidative crosslinking. This means the paint takes a long time to dry. Ford's black paint was applied by hand brush in multiple coats, a process that, took almost a week to complete. This caused terrible production bottlenecks for Ford's innovative mass production process and jammed the assembly lines. This process bottleneck was the motivation for the first paint specifically developed as an automotive coating: DuPont's 'Duco' paint. This new coating technology reduced the painting and drying time from many days to a few hours.

This was the first example of how industry needs have drove the advance of automotive coatings technology. Since then advances and innovations in automotive coatings technology have continued unabated.

It was not until the 1950s that the next major automotive coatings advance occurred. By then, the automobile was no longer just a means of transportation. Cars had now become a personal showpiece that owners wanted to flaunt. That meant that the coatings had to look better and accentuate the new curved styling body designs of the times. the use of thermoplastic acrylic lacquers. For this, the use of thermoplastic acrylic lacquers was introduced.

This coating technology had such an advantage for color styling that by the 1960s General Motors painted virtually every car with acrylic lacquer topcoats. But cars still had a major issue—rusting of the automotive body. A major coatings advance in the 1970s resolved this issue: electrodeposition primers, commonly known as "e-coat." This was of the biggest breakthroughs in automotive coatings technology. Modern electrocoat automotive primers are applied by totally submerging the assembled car body in a large tank that contains the waterborne e-coat, and the coating is applied through cathodic eletrodeposition.

In the 1990s, another major development occurred in the formulation of automotive coatings: the use of waterborne basecoats.

The final major step change in automotive coatings technology occurred in the 2000s, and this advance focused on process efficiency. In the typical automotive assembly plant, the painting operation can take up to half the space of the entire facility, account for approximately 40% of the capital cost of an assembly plant, use 80% of the energy, and produce the vast majority of CO_2 and VOC emissions! OEM manufacturers have asked the paint suppliers to find a way to reduce this footprint and the cost of applying the coating system. This has required paint formulators to develop coatings that can be applied more efficiently, in fewer steps, and with a lower energy requirement.

Automotive coatings, like most others, are used mainly to provide protection and decoration. The main concerns for automotive coatings 20 years ago were corrosion and fade/gloss from sunlight, acid rain, and other degradations. Most coatings had a useful life of about five years. Today, with advancements in chemistry, formulation, and processing, automotive coatings have useful lives of more than 10 years.

According to a report by the Business Research Company, the automotive coatings market is expected to grow to $24.55 billion in 2026 at a CAGR of 7.2%. The increasing demand for lightweight vehicles is significantly contributing to the growth of the automotive coatings market. Additionally, the new developments in coatings and specially designed coating for EVs are also opening new avenues for the automotive paints and coatings market. The Russia-Ukraine war disrupted the chances of global economic recovery from the COVID-19 pandemic, at least in the short term. The war between these two countries has led to economic sanctions on multiple countries, a surge in commodity prices, and supply chain disruptions, affecting many markets across the globe.

The development of the market is considerably boosted by the expansion of the automobile sector globally. The manufacturers in the automotive refinish coatings market are increasing the market share by improving the product offering and introducing new products in the market. BASF SE, Covestro AG (Germany), KAPCI Coatings (Egypt), Nippon Paint, Mitsui Chemicals, Inc.,Kansai Paint Co., Ltd (Japan), Akzo Nobel N.V (The Netherlands), KCC Corporation (South Korea), PPG Industries, Inc., 3M, The Lubrizol Corporation, The Sherwin-Williams Company, Axalta Coating Systems, LLC, The Valspar Corporation (US), Growel & Weil (India) Ltd., Esdee Paints Limited and Berger Paints India Limited (India) are the notable players functioning in the market.

The Asia Pacific region is growing due to the rapid industrialization in the region during recent years. Nations such as South Korea, India, China, Japan, and Malaysia are the main contributors to the evolution of this regional market. The market progress is influenced by factors such as rising urbanization, altering lifestyles, growing buying power of the population, and an increasing level of consumer awareness for the maintenance and protection of vehicles.

The constant upgradation in technologies has led to a better quality of automotive refinish coatings. However, increase in vehicle safety solutions have reduced the number of accidents, thus restricts the growth of paints coatings refinish market. Nonetheless, rising adoption of eco-friendly paints and coatings due to stringent government regulations for gas emission and environmental concerns related to paint & coating manufacturing processes are expected to drive the automotive paints & coatings market in the coming years.

Strategic collaborations between companies have emerged as a key trend gaining popularity in the automotive coating market. Companies in the automotive coating industry are undergoing various collaborations to develop new technologies and products. For instance, in 2020, IGL Coatings, a pioneer in ceramic and automobile eco-friendly coatings, announced a strategic partnership with Yamaclar, a multi-generational Turkish company that manufactures various automotive paints, for the distribution of its products in Turkey. Moreover, BASF, the

Germany-based automotive coatings manufacturer last year expanded its Automotive Coatings Application Center in Mangalore, India as an integral part of BASF's existing research and development (R&D) facilities for automotive coatings solutions. The automotive coatings application center covers over 400 square meters of floor area and is equipped with state-of-the-art equipment, such as high precision climate-controlled spray booth and electrostatic rotary bell applicators, and advanced quick connection system for electrostatic applications. The facility is meticulously designed to enable customer-oriented R&D activities coupled by accurate simulation of OEM paint shops.

"The expansion of the application center is an important addition to serve the Indian market with high-quality coatings solutions. It symbolizes our strong commitment to supporting the automotive industry's long-term growth in India," said Narayan Krishnamohan, Managing Director, BASF India Ltd. and Head, BASF Group Companies in India.

"This investment is a significant milestone in our effort to further strengthen our R&D footprint in Asia Pacific, as well as improve our proximity to customers in one of the fastest growing regions for our automotive coatings solutions," said Patrick Zhao, Senior Vice President, BASF Coatings Solutions Asia Pacific. "With the expanded automotive coatings application center, we aim to not only continue our investment in OEM coatings in India, but to also support long-term growth in the automotive market in the region going forward."

Growel's Geomet zinc aluminium flake coatings

Automobiles, by design, feature metallic parts which are prone to the elements of extreme atmospheric conditions. Corrosion resistance then becomes indispensable. In such a scenario, OEMs must use chemically coated parts, primarily zinc-aluminium flake coating, because of its versatility and unique properties like galvanic corrosion against aluminium, lubricity, etc.

Growel is a one-stop solution provider for the protection of all types of substrates across various industrial segments. The Paints Division (erstwhile Bombay Paints Ltd) of Growel, is a leading supplier of super build surface tolerant & high chemical resistant coating systems to the heavy duty industrial, pipeline, marine, original equipment manufacturers (OEM)

segments. Of late, Growel has introduced a range of products for the architectural segments also.

Their success is fuelled by their relentless quest for 'Excellence' and continuous efforts in redefining ways in which we approach our business. Research & Development together with strategic tie-ups, play a key role in maintaining technological leadership in all business areas. Continued product innovations and new developments have empowered them to move into newer business segments and achieve path-breaking success in them.

Growel promises the best and delivers on it. It's no wonder then that they have a long-standing relationship with Japan's number one zinc aluminium flake coating manufacturers NOF Metal Coating's Asia Pacific Co. Ltd.

The Geomet® process is well established, superior in technology, and environment-friendly. It is used in many industries throughout the world, such as automobiles, windmills, engineering, electricals & electronics, white goods, mining, railways, process industry, and defence.

So what's the Geomet® ? GEOMET® Treatment is, high corrosion resistance surface

treatment which can perform at less than 10μm thickness and single structure-based film. The coating is water based chemistry patented as 'GEOMET®' and contains inorganic silver-grey deposits essentially comprising zinc & aluminum flakes, uniformly distributed on the entire substrate.

What are the applications of the Geomet® process? The Geomet® process covers the protection of variety of components items like fasteners, springs, brake discs, sheet metal parts etc. GEOMET® coatings are highly recommended by various OEMs for high tensile steel fasteners hence there is no hydrogen embrittlement occurrence from the treatment process. The application of PLUS® series of topcoats are used for improved lubricative properties i.e reduced COF values and additionally improves protection against corrosion. Both processes provide outstanding protection to metallic surfaces against corrosion at film thickness as low as 8~10 microns. The Geomet® is one of the most environment friendly coating system which generate very less waste water and CO_2 emission from the treatment process comparing to other surface coating or plating systems.

3M launches ceramic coating for the Indian automotive aftermarket

3M India had recently announced the launch of ceramic coating for the Indian automotive and paint industry. The product has been launched to offer an improved solution to all issues related to exterior car surfaces. 3M Ceramic Coating provides a hydrophobic finish that makes it suitable for water beading, thus maintaining surface durability, the company said in a press release.

Mr P. T. Mukund, Director, Automotive Aftermarket Division – Asia, 3M, said, "Asia Pacific region is expected to be 40% of the global market of ceramic coatings, and at 3M, we have always strived to cater to the needs of Indian customers."

"Given the extreme weather conditions in India, the automotive aftermarket has always been on the search for the most durable coating for car owners. With that in mind, we are optimistic and enthusiastic that the launch of Ceramic Coating will give customers the best user experience and functionality," he added.

Formulated after years of research and development, 3M has combined its science and real-world performance for the 3M Ceramic Coating treatment. The product helps to enrich paint gloss and shine for a durable new-polish look for car owners and OEMs.

Amlendukumar Singh, Manager AAD, 3M India, said, "3M's ceramic coating is yet another innovation that we are extremely proud to present in India. The formulation has been perfected to last up to five years. It's engineered in a way so that one formula can

be used on paint, plastic trim, wheels and glass."

BYK innovation makes applications lightweight, more stable and safer

BYK Additives is launching BYK-MAX CT 4275 to the market, a novel, specially developed additive that can be used in a wide variety of polyamides - for example in the automotive industry. The optimized surface treatment and the unique morphology of the silicate provide improved dispersion and incorporation into the thermoplastic matrix while ensuring near-perfect exfoliation in polar systems.

The highly reinforcing mechanism of BYK-MAX CT 4275 improves, among other things, flexural modulus, yield strength, tensile strength and heat deflection temperature, while ensuring excellent flow behavior of the composite. This makes it possible to form thinner components and thereby reduce weight.

In mineral and glass fiber-filled thermoplastic composites, the additive enables a lower total content of mineral and glass fibers without comprising the mechanical properties; it is therefore the ideal solution for lightweight construction applications, for example in the automotive sector. In addition, BYK-MAX CT 4275 will also have a positive effect on surface properties, scratch resistance and flow behavior.

The new additive does affect the density of the compound, thus offering weight reduction. It is highly miscible and requires no special processing steps.

Nippon Paint launches n-MAX range of automotive refinish paints

Nippon Paint India, part of the NIPSEA Group, has launched a new international automo-

tive refinishes product system under the n-MAX brand. With this launch, Nippon Paint is expanding its presence in the Indian and International car refinishing markets through its new state of the art product line that is designed to excel in all geographical regions and weather conditions across the world.

The n-MAX range includes N Max SB - equipped with a vast range of OEM colour formulations and supported by its advanced Nippon Paint Partner digital colour retrieval system with 5 angle spectrophotometer. The colour range is supplemented by Nax Pro LV, a low VOC range of clear coats, primers and auxiliaries from Europe & Nax Pro EZ which offers a complimentary range of high performance, value based ancillaries.

Talking about the range, Mr Sharad Malhotra, Sr. Vice President, NIPSEA Group Automotive Refinishes said, "The n-MAX launch reflects our global aspiration to develop and offer quality products in the international automotive refinishes market. The product has been developed by the core technology group in India and is a powerful statement of intent from our side. We hope to make this brand successful not only in India but across the world. We are confident that our technology and product quality is superior and we are keen to add tremendous value to our customers paint processes, in line with our vision to be paint process specialists."

Mr A. Prateesh, General Manager (Marketing), NIPSEA Group Automotive Refinishes added, "n-MAX range is introduced to offer quality tinting solutions with very low

investment. This is a state-of-the-art product line for independent body shops and collision repair centers. The aim is to build long term partnerships with distributors by offering advanced technology at competitive pricing along with value added services. The range has been designed with the goal to give utmost ease to retailers and automotive bodyshops. We have launched this brand under our Refinish 2.0 stream which will witness more launches in times to come."

From sustainable paints to electronic coatings

The BMW Group is using innovative technologies in its efforts to improve sustainability and taking advantage of new options to conserve resources and reduce emissions from painting bodywork. The BMW Group is the first automotive manufacturer worldwide to use matt paints made from biomass instead of crude oil at its European plants. In addition to this, BMW Group Plants Leipzig and Rosslyn (South Africa) are also using sustainably-produced corrosion protection. Renewable raw materials such as bio-waste or waste from sewage treatment plants serve as the starting material for the paints. The CO_2 savings determined in a TÜV-certified process amount to over 15,000 tonnes of CO_2 emissions between now and 2030.

"By reducing our use of fossil raw materials, we can conserve natural resources and lower CO_2 emissions at the same time. To achieve this, we are increasingly relying on sustainability innovations in our supplier network," says Joachim Post,
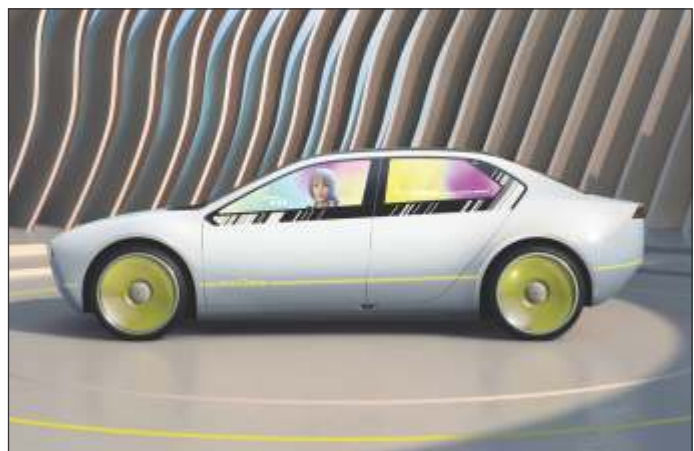

PHOTO: BMW

member of the Board of Management of BMW AG responsible for Purchasing and Supplier Network. "Innovative paints based on renewable raw materials are an important step in this direction."

BASF's innovative production process makes it possible to replace petroleum-based precursors, such as naphtha, with renewable raw materials from organic waste, starting in the early stages of paint production. This not only reduces consumption of fossil resources, but also avoids the CO_2 emissions associated with the production, transport and processing of crude oil.

Forget the basic stuff of automotive coatings. What if the color of your car could change on demand depending on your mood of the day, or simply the weather? Well, that's the latest!!! BMW has just revealed their latest futuristic mid-size sedan the BMW I Vision Dee and describes it as the world's first 'color changing' car. The 'Dee' stands for Digital Emotional Experiencce! The car can cycle between 32 different solid exterior colors, with mix-and-match capabilities due to its 240 different panel segments. That's a significant leap past BMW's earlier

iteration showcased last year, which could only alternate between black, white and gray.

The Dee's outer skin is a film made of electronic paper built by a startup called E Ink, which also makes display tech for e-readers and mobile phones. The coating segments contain millions of tiny microcapsules with different color pigments that change shades when electricity is applied. Eventually, BMW hopes to develop a spray coating that would help the color-changing panels stand up to the elements,

The electronic coating is "ultra-low power," so changing the car's colors won't drain the electric vehicle's battery.

BMW hasn't released specs for the Dee's engine or battery, but says the concept car is additionally loaded with futuristic hardware and software that'll be available in cars on the road by 2025. For BMW, the car is meant as a glimpse of what could eventually be a much more colorful future. "This allows an almost infinite variety of patterns to be generated and varied within seconds," the company said in its press release, which described the light show as a "magical display of color."

Vishnu Chemicals Ltd in expansion mode

Vishnu Chemicals Ltd., is expanding to include high-quality niche specialty chemicals for the paint industry

Vishnu Chemicals Limited (VCL) epitomizes manufacturing of high-performance specialty chemicals, with strong market leadership and an intelligent symphony of forward and backward integration to produce world-class products that are focused on diverse needs and aspirations of its customers. VCL is India's largest manufacturer of chromium and barium chemicals with a strong moat of being the most efficient manufacturer and a global leader in a niche industry. Established in the year 1989 by visionary

Mr Krishna Murthy Cherukuri, Chairman and Managing Director, the journey over the past three decades reflects the persistence with which the Company has been built brick-by-brick. At all times, Vishnu Chemical's leadership has remained committed and always believed that the Company would create value through dedicated efforts towards manufacturing, enabling the Company to keep marching on its chosen path.

Ever since its inception, the Company has aggressively grown both in an organic and

The manufacturing facilities are certified with global standards for quality and manufacturing excellence.

inorganic way. VCL is also the sole manufacturer of a variety of chromium-based chemicals in Southeast Asia. Today the company has consolidated its position as a dependable supplier for 100+ customers across industries like pharmaceuticals, electroplating, leather, pigments and dyes, ceramics, glass, refractory, plastic, detergents, etc. The Company's products and processes conform to global standards, which is a testimony of product quality and reliability. It supplies its products in all the major geographies including Asia, Europe, the Americas, Africa, and Oceania among others. VCL is also strengthening its global outreach program and expanding its operations in the United States of America.

The Company has delivered good profit growth of 64.8% CAGR over last five years. The company is consistently investing in research and development along with upgrading to new technologies to deliver superior quality products to its customers.

"Manufacturing is our focus. I am very satisfied to share that the company is operating at record operating levels. By improving continuously, Vishnu has built a state-of-the-art infrastructure that enables us to be a company of choice in the sector we operate. With our targeted investments, we will continue to drive long-term growth above market growth rates by providing value to our customers around the world," said Mr Krishna Murthy Cherukuri.

Mr Krishna Murthy Cherukuri is one of the most prolific business leaders and industrialists in the specialty chemicals sector. He has spearheaded the Company over the last three decades, scaling the company to new heights and promoting a diverse and inclusive company culture to promote performance and wellbeing.

"Our persistence and commitment to maximize the benefits of our scale and experience in chemistry are reaping benefits. We are

PHOTOS: VCL

Mr Krishna Murthy Cherukuri, Chairman and Managing Director (left) with Mr Siddartha Cherukuri, Joint Managing Director, Vishnu Chemicals Limited.

continuously improving our manufacturing processes that combine environmental and economic benefits by comprehensive use of resources and the ability to handle complex reaction media," said Mr Krishna Murthy Cherukuri, who works closely with production, strategy and finance teams to ensure growth is in line with the goals of the company.

"Our chromium chemicals are proven to be of high value as they possess properties of high corrosion resistance, durable colors and uniformity, which improves the performance and life of industrial components, pigments and dyes," said Mr Siddartha Cherukuri, Joint Managing Director, Vishnu Chemicals Limited. "Manufacturing is our core focus. The chemistry we operate is an essential engine for change and innovation. We epitomize manufacturing of unique range of specialty chemicals and have evolved as a global name to reckon with. We have two product portfolios: chromium chemicals and barium chemicals. Under these two product portfolios, we have a range of products that include sodium dichromate, chromic acid, chrome oxide green, sodium sulphide, white sodium sulphate, basic

By improving continuously, VCL has built a state-of-the-art infrastructure that enables them to be a company of choice in the sector they operate.

chrome sulphate and barium carbonate amidst others. The properties of our specialty chemicals make the industrial parts more versatile and indispensable, by making them resistant to corrosion, oxidation and reducing wear and galling. Our chromium chemicals are proven to be of high value as they possess properties of high corrosion resistance, durable colors and uniformity, which improves the performance and life of industrial components, pigments and dyes."

To highlight certain use case scenarios, VCL manufactures:

☐ High quality crystal sodium dichromate used for pigments and coatings, metal passivation and as an oxidizing agent.

☐ High-purity chromic acid is used to manufacture metal and plastic coatings to produce a strong, tarnish-resistant, chrome finish. It finds applications in many industries including in the manufacture of appliances and automobiles.

☐ Their product Chrome Oxide Green is used as an inorganic pigment in paints, architectural coatings, plastics, roofing tiles and ceramic tiles. Chrome Oxide Green is also used in heavy-duty applications in the construction of high-temperature and abrasion-resistant refractory brick for glass and fiberglass.

☐ In barium chemicals, the company manufactures barium carbonate which is used in the manufacturing

of electro-ceramic materials, glazes, bricks, frits and enamels. It is widely used as a welding electrode coating and in glass manufacturing processes as a purifying agent for uniformity in glass melt, along with application in caustic lye brine purification process.

Sustainability at the center

"Sustainability is at the center of everything we do at Vishnu Chemicals Limited. Over the years, we have been a growth catalyst to our customers across diversified applications embracing changing preferences and sustainability. At Vishnu Chemicals, the commitment to conservation of environment and contribution to people's health, remains constant. The Company is continuously adopting new techniques to eliminate and minimize the environmental impact. Solar initiatives are being undertaken to use greener sources of energy wherever possible," said Mr Siddartha Cherukuri.

VCL manufactures an of unique range of specialty chemicals and have evolved as a global name to reckon with.

Through its R&D initiatives, VCL has improved continuously and upgraded systems to lend a sustainable competitive advantage to its customers.

On the new product in barium chemical, Mr Siddartha Cherukuri shared, "Climate change is a real thing today. Renowned researchers have created the world's whitest paint using a barium chemical. This paint has entered the *Guinness Book of World Records* for its ability to reflect 98.1% of sunlight. Hence, it cools outdoor surfaces by more than 4.5°C thus cutting down the consumption of electricity and use of energy."

"This innovation, we believe is path-breaking as it delivers results to your homes and offices in the most effective manner," emphasized Mr Siddartha Cherukuri, a person passionate about manufacturing across industries and who enjoys sports and fitness in his leisure time. "We are really excited about this development as we ourselves are currently expanding to manufacture the best quality precipitated barium sulphate for the global markets under our Barium Chemicals portfolio. Our product is an inorganic compound and is a high-purity, synthetic additive that is produced in a carefully controlled manufacturing process."

R&D helps expand product portfolio

Their R&D initiatives help them identify niche compounds that have synergies with their existing manufacturing processes and continue to expand their portfolio with niche products that have high barriers to entry or are import substitutes. "We are in process of expanding our capacities in both chemistries to meet the rising demand of our customers and innovative end-use applications," said Mr Siddartha Cherukuri. "We are focused on expanding our market share in the American continent by providing high-quality specialty chemicals combined with value-driven sales and service, enhancing customer satisfaction."

Their performance is an outcome of simple yet effective changes made over the years, said Mr Siddartha Cherukuri. Firstly, they integrated their processes as much as possible while maintaining a well-organized and well-controlled manufacturing line. Secondly, they focused on the business as a whole not only the production assets but also the logistics, sales and talent development.

"Robust demand environment continues to drive enquiries for our products as they are essential to extending the life, imparting colors and improving the performance of many consumer and industrial components such as construction equipment, wind turbines, and engine pistons," said Mr Siddartha Cherukuri, as he leads the strategy and international marketing efforts of the company. "We have established long-standing relationships with our customers as they trust us for our high-quality chemicals and on-time delivery commitment, making us a preferred supplier domestically and internationally."

VCL's supply footprint includes all the major geographies including Asia, South East Asia, Europe, UK, North, South and Central America, and Africa among others. In FY 2021-22, their domestic and exports sales each grew by more than 50% despite pandemic-induced disruptions globally. Today, VCL is also the largest manufacturer of chromium and barium chemicals in India, with a global market share of nearly 10% in their chemistries.

They have added chromic acid, chrome oxide green and sodium sulphide in their chromium chemicals range which is in good demand globally. In the barium chemicals portfolio, they are currently expanding to manufacture the best quality precipitated barium sulphate for the paint industry.

VCL maintains its production operations from its four dedicated facilities across India covering more than 300,000 sq. m. of area under operations and 1000+ people strength. The facilities are located in Andhra Pradesh, Telangana and Chhattisgarh. The manufacturing facilities are certified with global standards for quality and manufacturing excellence. R&D is its key lever to exceptional performance. Through its R&D initiatives, Vishnu has improved continuously and upgraded systems to lend a sustainable competitive advantage to its customers.

"We have industry-leading expertise, a global footprint, and clear priorities with plenty of room for growth. We have strong plans to expand our capacities and increase our global market share five years from now to emerge as a global leader. Our unwavering focus will remain on manufacturing, and industry leadership in terms of ROCE," he signs off.

VCL is the sole manufacturer of a variety of chromium-based chemicals in Southeast Asia.

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Decarbonizing hydropower with industrial coatings and repair composites

Protective coatings and repair composites play an important part in implementing and raising the sustainability standards within hydropower facilities

Considering the imminent exponential growth of the hydropower industry, it is essential that an arsenal of strategies is implemented in order to raise the sustainability standards within hydropower facilities - driving the industry towards a net zero future.

Of these strategies, protective coatings and repair composites have an important part to play. By intrinsically improving the integrity of key hydropower assets, these products help to accelerate the drive towards more sustainable hydropower facilities and, therefore, the decarburization of the sector.

The carbon footprint of hydropower

While the environmental benefits of hydropower far outweigh fossil fuel alternatives, like most alternative energy sources, hydropower is not without its carbon footprint. Indeed, all energy sources, even renewables, produce carbon emissions in their lifecycle, due to the emissions caused by their manufacture, construction

and operation.

While there are some hydropower facilities, such as Iceland's Landsvirkjun, which have pledged to become carbon neutral, on average, the Intergovernmental Panel on Climate Change (IPCC) states that hydropower has a median greenhouse gas (GHG) emission intensity of 24 gCO_2-eq/kWh. This is the grams of carbon dioxide equivalent per kilowatt-hour of electricity generated allocated over its life-cycle. By comparison, the median figure for coal is 820 gCO_2-eq/kWh.

Hydropower capacity needs to double by 2050

The need to mitigate this carbon footprint somewhat ratchets up when considering the huge role hydropower is set to play in supporting a net zero emissions by 2050 pathway (in line with The Paris Agreement).

In the International Energy Associations (IEA) 'Net Zero by 2050 Roadmap' (revised version 2021), the required growth of hydropower is colossal. The Roadmap states
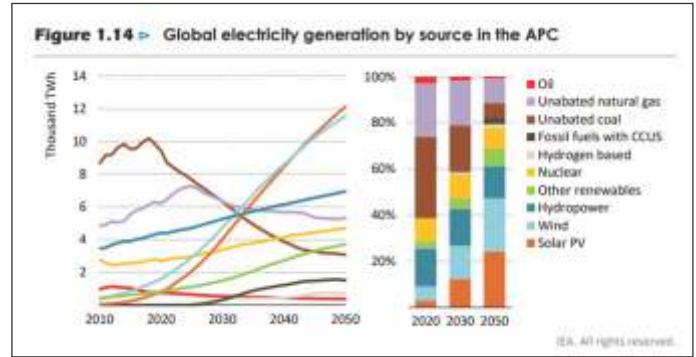
IMAGE SOURCE: INTERNATIONAL ENERGY ASSOCIATIONS (IEA) NET ZERO BY 2050 ROADMAP

that hydropower capacity needs to 'double by 2050,' positioning the industry as [...] the third-largest energy source in the electricity mix by 2050.'

A call to modernize aging plants

While it is essential that hydropower capacity 'doubles' by 2050, one way of increasing this capacity is by, what the IEA describes as 'modernizing ageing plants'. In fact, their Roadmap details how between now and 2030, USD 127 billion – or almost one-quarter of global hydropower investment – will be spent on modernizing ageing plants.

In regards to these 'ageing plants', according to the IEA, in North America, the average hydropower plant is nearly 50 years old and in Europe, the average is 45 years old.

The report goes on to say how: 'These ageing fleets – which have provided affordable and reliable renewable electricity on demand for decades – are in need of modernization to ensure they

can contribute to electricity security in a sustainable manner for decades to come.'

Extend lifespan of hydropower assets with industrial coatings and composites

Industrial protective coatings and epoxy repair composites play a fundamental role in 'modernizing ageing plants', which in turn, supports the decarburization of the hydropower industry.

By investing in this polymeric technology, aged assets can be repaired, protected and improved for the long term. This process successfully helps to mitigate the carbon footprint of hydropower facilities as it breathes new life into assets that would otherwise be decommissioned, replaced or sent to landfill.

Companies such as Belzona (established in 1952) have a portfolio of protective coatings and repair composites that have been used to improve the efficiency and performance of hydropower assets for decades.

SOURCE: IPCC
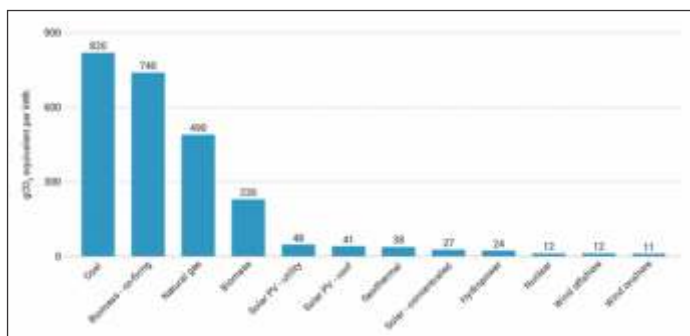
Average life-cycle CO₂ equivalent emissions.

Turbine prior to application, visibly damaged.

First coat of epoxy coating, Belzona 1341 (Supermetalglide), applied.

Based on the level of erosion resistance required, the epoxy paste, Belzona 1111 (Super Metal) and composite repair polymer, Belzona 1311 (Ceramic R-Metal), can be specified for rebuilding damage and restoring efficiency in areas such as turbines, wicket gates and turbine casings.

The efficiency improving capabilities of these systems can be demonstrably identified in the two-part epoxy coating, Belzona 1341 (Supermetalglide). With this high-performance coating, the efficiency of fluid handling equipment, such as pumps,
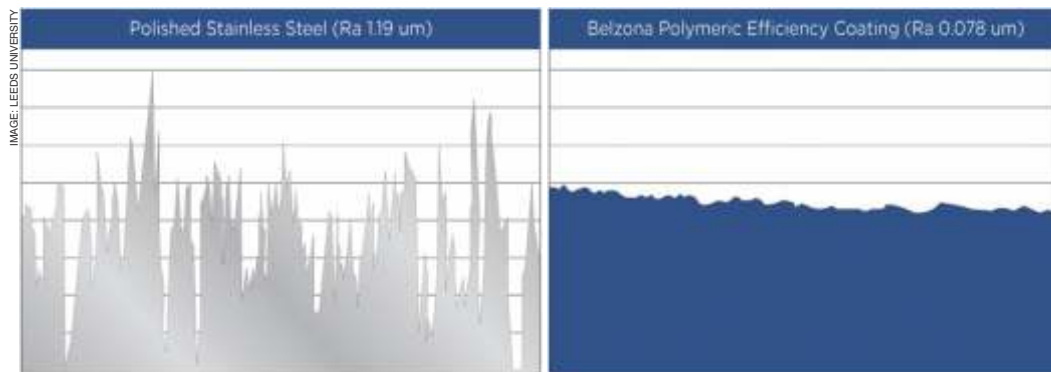
Roughness comparison between polished stainless steel and Belzona 1341 (Supermetalglide).

can be increased by up to 7% on new equipment and up to 20% on refurbished equipment.

As seen in the graph above, in a study carried out by

Leeds University, it was found that when compared to polished stainless steel, Belzona 1341 (Supermetalglide) was 15 times smoother.

The two-part polyurethane resin, Belzona 2141 (ACR-Fluid Elastomer), can be deployed in areas that are particularly subjected to high levels of cavitation, such as Kaplan turbine blades. This system offers an outstanding level of protection against cavitation at ultra-high velocities (up to 115 knots with no damage).

'Belzonas range of polymeric systems can be specified in the following application areas, amongst others: turbines, penstock gates, generators, spiral casings,

draft tubes, transformers, powerhouses, control valves, dams, stilling basins and spillways.

Mitigating hydropower's carbon footprint

By investing in industrial protective coatings and epoxy repair composites, the lifespan of hydropower assets can be considerably prolonged. In turn, this supports more sustainable operations within hydropower facilities and, therefore, helps to mitigate the carbon footprint of the industry.

Application of Belzona 2141 (ACR-Fluid Elastomer) on Pelton turbine nozzle head.

*Author: **Chloe Hirst**, E:chirst@belzona.com; W: belzona.com*

Data-driven pitting evolution prediction for corrosion-resistant alloys by time-series analysis

Abstract

Corrosion initiation and propagation are a time-series problem, evolving continuously with corrosion time, and future pitting behavior depends closely on the past. Predicting localized corrosion for corrosion-resistant alloys remains a great challenge, as macroscopic experiments and microscopic theoretical simulations cannot couple internal and external factors to describe the pitting evolution from a time dimension. In this work, a data-driven method based on time-series analysis was explored. Taking cobalt-based alloys and duplex stainless steels as the case scenario, a corrosion propagation model was built to predict the free corrosion potential (E_{corr}) using a long short-term memory neural network (LSTM) based on 150 days of immersion testing in saline solution. Compared to traditional machine learning methods, the time-series analysis method was more consistent with the evolution of ground truth in the E_{corr} prediction of the subsequent 70 days' immersion, illustrating that time-series dependency of pitting propagation could be captured and utilized.

Introduction

Corrosion initiation and propagation have the characteristics of randomness, dynamics, and the coupling of internal alloy factors and external environmental factors[1,2,3,4]. This involves the rupture or dissolution of the passive film in corrosive environments, the dissolution rate of the metal on the pitting surface and the dissolved metal at different moments, as well as the diffusion rate of cations in the corrosive solution[5,6]. These factors jointly influence the local chemical environment and the dynamic evolution of pit morphology with the corrosion time, which in turn determine the design of the material composition and structure. Researchers have carried out numerous experimental and theoretical studies on pitting mechanisms, describing pitting evolution as either discrete and macroscopic or continuous and microscopic[7,8,9]. From the perspective of alloy service time, pitting initiation and propagation are closely related to the interactions between local corrosion conditions and material structure, which can evolve and accumulate continuously with corrosion time. To date, making accurate predictions of pitting propagation for corrosion-resistant alloys requires capturing past corrosion phenomena to estimate future possibilities, which has remained a great challenge[1].

Artificial intelligence (AI) and machine learning (ML) can capture complex relationships between multi-dimension factors and targets; thus, promoting new materials and insight discovery[10,11,12,13,14,15].

Since the 1980s, researchers have applied artificial neural networks, random forests, and other machine learning algorithms to predict the uniform corrosion of materials and design new corrosion-resistant materials, making notable progress in solving the multi-factor coupling corrosion problem[16,17,18,19,20,21]. This has helped to predict the corrosion rate of low alloy steel and carbon steel, analyze the important factors that affect the corrosion rate, and forecast the local corrosion behavior of Co-based alloys under different compositions, preparation processes, temperatures, static corrosion environments, and corrosion times[22,23,24,25,26]. Coelho et al. provides a data-oriented overview of the rapidly growing research field covering ML applied to predicting electrochemical corrosion, which highlights assessing the predictive power of different approaches and elaborate on the current status of regression modeling for various corrosion topics[27]. Sharma et al. have employed Random Forest method to model measurements of corrosion rates of carbon steel as a function of time when corrosion inhibitors are added in different dosage and dose-schedules[28]. However, traditional statistical analysis methods, such as support vector machine, random forest and gradient boosting regression default to the assumption of independent and identical distribution among the data samples. For the dynamic process of material service, traditional analysis methods cannot use the inherent time-series relationship between the data samples. Time-series data analysis methods, such as the well-known long short-term memory (LSTM) neural network, can perform dependency mining on sequence data, and learn functions that map a sequence of past observations as an input to output observation[29]. By introducing input gates, forgetting gates, output gates, and memory units, the information in the memory units can be maintained, updated, or forgotten at different moments to solve the problems of gradient disappearance and sequence dependencies under long-term time series[30]. Thus, the time-series data analysis method can provide a prospect for the evolution prediction of pitting propagation.

In this work, using cobalt-based alloys and duplex stainless steels as the case scenario, we explored a machine learning method based on the time-series analysis of an LSTM neural network. We constructed a pitting propagation model of free corrosion potential (E_{corr}) based on a 150-day immersion test in saline. Traditional machine learning algorithms were compared
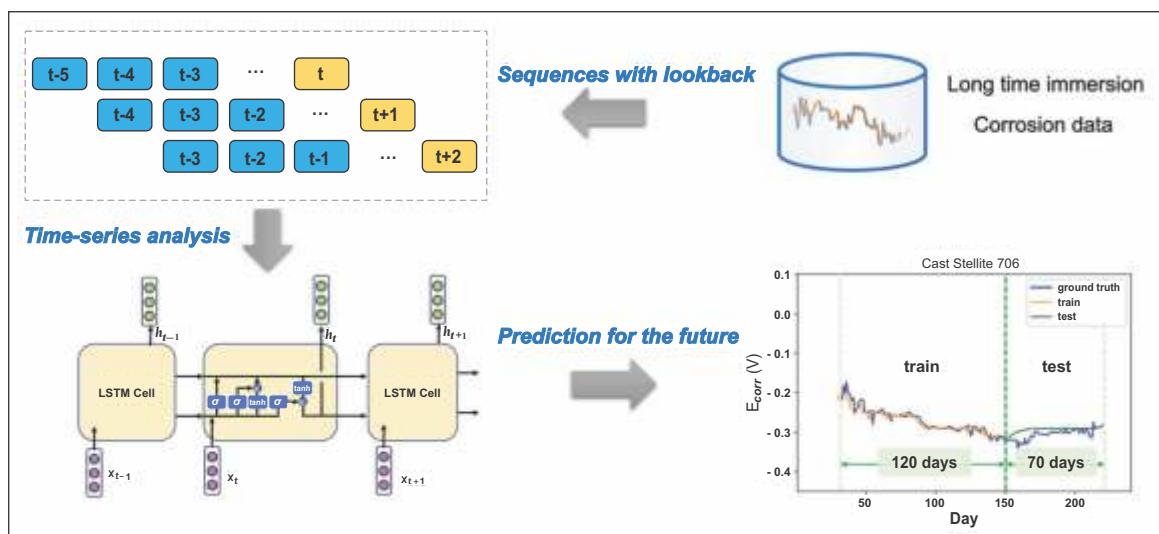
Fig 1: The workflow diagram of machine learning. The collected dataset are transformed into sequences with appropriate lookback to maintain the information of former moment. Then LSTM neural network is trained to capture the dependences, and it is finally used to conduct future prediction for the following days' pitting.

(days from 30 to 150), along with the target property of E_{corr}.

Traditional machine learning models

Firstly, traditional machine learning algorithms have been used, including support vector regression (SVR), k-nearest neighbor regression (KNR), gradient boosting regression (GBR), random forest regression (RFR), and AdaBoost regression (AdaBR)[31]. Machine learning algorithms regarded immersion time as one of the conditionally independent feature variables, capturing the relationship between the different chemical compositions, immersion times, and E_{corr}. The chemical composition, HV, standard deviation of

with the LSTM, which were further applied to estimate the Ecorr of the following 70 days in future immersion. The LSTM model was more consistent with the evolution trend of the ground truth outlined by experimentation, illustrating that the time-series analysis method could capture the sequence dependencies of pitting propagation under a long-term time series attributed to the network structure. This may pave a promising approach for other material services and lifetime behavior predictions.

Results and discussion

Machine learning strategy

The machine learning strategy starts with data collection, goes through sequence transformation, time-series analysis, and finally predicts future pitting behavior (Fig 1). The whole dataset was prepared by long-time immersion for four different alloys of Stellite 6, Stellite 12, Stellite 706, and Zeron 100. Long-term immersion tests were conducted in 3.5 wt. %

NaCl solution at 18°C for 150 days. E_{corr} was measured every day during the immersion period for half a year.

Fig 2 shows the E_{corr} values of the samples versus the immersion time for 150 days. During immersion, visible pitting was first observed around 30 days for all alloy samples. Thus, we manually

removed the first 30-day data, because pitting was in the initiation stage during this time, and E_{corr} fluctuated greatly. Therefore, the dataset consisted of 480 entries in total, including the composition of each alloy, Vickers hardness (HV), and standard deviation of HV, as well as the immersion time of 120 days
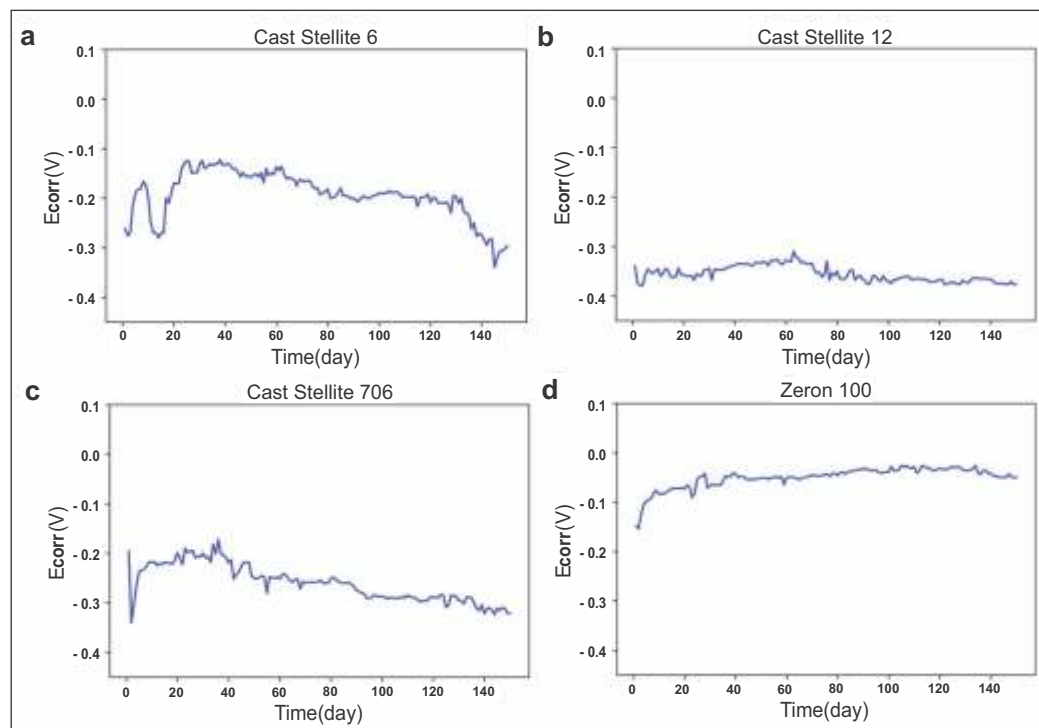
Fig 2: The visualization of original dataset for different alloys. The free corrosion potential (E_{corr}) values measured during the immersion period of 150 days: **a** Cast Stellite 6, **b** Cast Stellite 12, **c** Cast Stellite 706, and **d** Zeron 100.
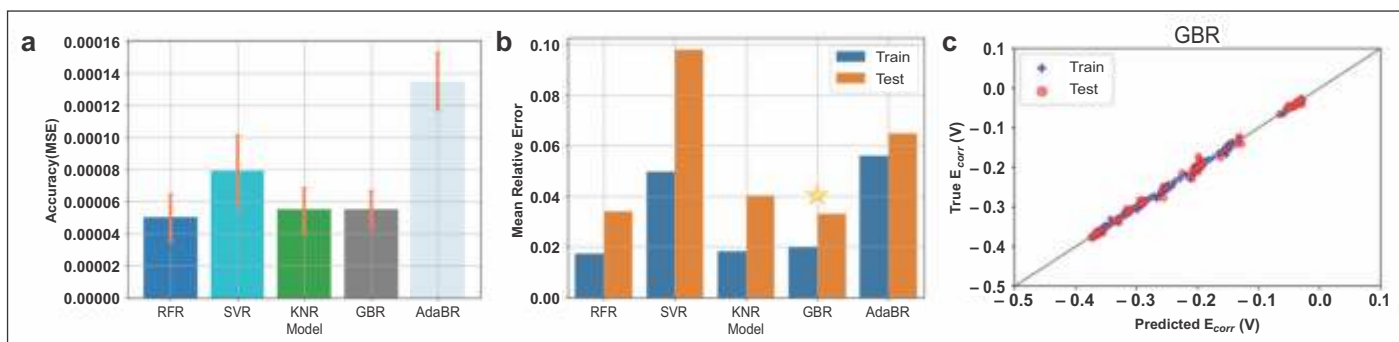
*Fig 3: Evaluation for traditional machine learning models. Parameter tuning and model selection of the traditional machine learning models: **a** The mean squared errors with variances (error bars) of the parameter tuning process for RFR, SVR, KNR, GBR, and AdaBR; **b** The mean relative errors of machine learning models on the training set and testing set separately; **c** Diagonal scatter plot of the ground truth versus the predicted E_{corr} by GBR during training and testing, respectively. E_{corr} free corrosion potential, SVR support vector regression, KNR k-nearest neighbor regression, GBR gradient boosting regression, RFR random forest regression, AdaBRAdaBoost regression.*

HV, and immersion time were utilized as the inputs, with the target property E_{corr} as the outputs. Before model training, parameter tuning was performed to obtain the optimal model parameters. The whole dataset was randomly split with 80% as the training set (384 data entries) and 20% left as the testing set (96 data entries). Parameter tuning was employed on the training set using grid search by five-fold cross-validation with randomly selected hyperparameters for each machine learning algorithm.

We used mean squared error (MSE) as a metric for the error between the ground truth and predicted value under each hyperparameter. For five-fold cross-validation, the mean and variance of the five-fold MSEs were calculated to evaluate the comprehensive performance of all hyperparameters for each algorithm. Figure 3a shows the mean and variance values of the optimal hyperparameter for each algorithm. RFR performed the lowest mean MSE, while KNR and GBR also had a relatively low MSE; however, GBR exhibited a smaller variance, indicating that the GBR model would be more stable. Moreover, to evaluate the generalization capability intuitively, the models were also tested on the hold-out testing set with the optimal hyperparameter for each algorithm by the mean relative error (MRE) on both the training and testing sets (Fig 3b).

Although RFR exhibited better MRE on the training set than the other models, the difference in MRE between the training and unseen testing set was larger than GBR. Thus, GBR with a test MRE of 3.3% proved to have a better generalization ability and could be used for constructing the E_{corr} prediction model of pitting propagation. Figure 3c gives the diagonal scatter plot of the ground truth versus the predicted E_{corr} by GBR during training and testing respectively, illustrating good fitting.

LSTM neural network

To maintain the information of former moment, LSTM neural network was further trained to capture the time dependences. The LSTM neural network consists of a gated recurrent neural network (RNN) that can account for long-time dependencies, can perform dependency mining on sequence data, and learn a function that maps the sequence of past observations as an input to output observation[30]. LSTM can use memory cell c_t to remove or add information. c_t is composed of the input gate i_t, forget gate f_t, and output gate o_t (Fig 4).

The LSTM model was implemented by TensorFlow and Keras after transforming the original dataset to a set of training sequences with a sliding window, namely the lookback window[32,33]. For E_{corr} prediction of long-time immersion, lookback determined how many days of immersion data would be used to predict the E_{corr} of the next day. As shown in Fig 5a, lookback = 5 meant using the previous 5 days' E_{corr} to predict the E_{corr} on day 6, and the window kept moving to the right. The larger the lookback window, the longer the model would capture the sequence dependencies;
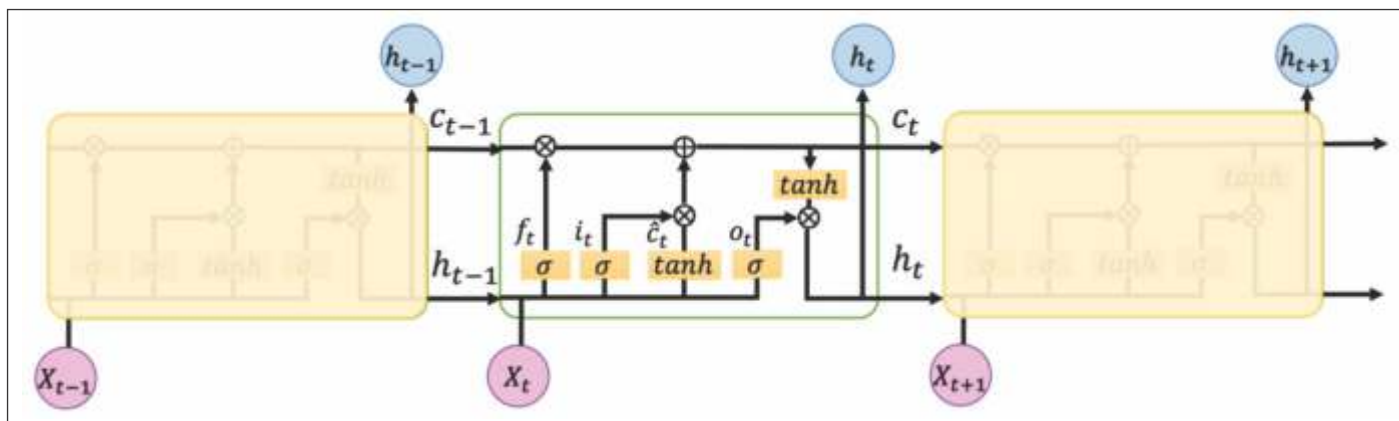

Fig 4: The internal structure of LSTM, including the forget gate, input gate, and output gate. The pink circle represents the input of different moment, the blur circle represents the hidden state of different moment.
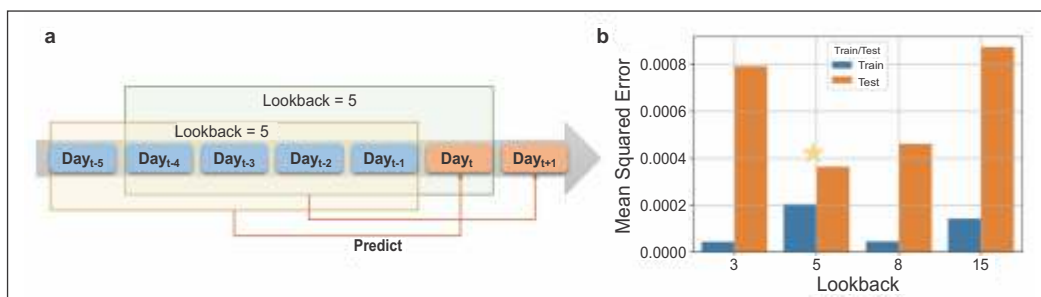
Fig 5: Schematic workflow and evaluation for LSTM neural network. The schematic workflow and parameter tuning for the LSTM neural network: a Schematic workflow used by the LSTM model with the time-series immersion dataset; b Taking Cast Stellite 6 as an example, the mean squared errors of the different lookbacks for the LSTM model on the training and testing set are shown. LSTM long short-term memory.

however, the fewer training sequences that would be generated based on 120 days (days 30–150) of data, and the model would be prone to overfitting. Thus, the smaller the window, the more training sequences that could be constructed; however, long-term sequence dependencies could not be captured, which required a tradeoff. We carried out parameter tuning of the lookback window for the LSTM neural network, as shown in Fig 5b. For each lookback length, the LSTM neural network was trained on the first 80% sequences as the training set and tested on the remaining 20% sequences as the testing set to evaluate the generalization ability. Figure 5b shows the MSEs of the different lookbacks for cast Stellite 6 on the training and testing set. We concluded that lookback = 5 was optimal, as the others resulted in overfitting.

Feature importance

To explore the contribution and importance of the alloy elements and immersion time in predicting E_{corr}, feature importance analysis was carried out by two different methods, namely the permutation feature importance and Shapley Additive exPlanations (SHAP) values[34,35]. The permutation feature importance was used to reveal the effect of the feature to the target by shuffling a single feature. Therefore, a decrease in the model score indicates that the model is highly dependent on the feature, especially for nonlinear estimators. Figure 6a shows the box plot of the permutation importance distribution based on the GBR E_{corr} model by repeating 50 times, where the features are shown in descending order according to their contribution to decreasing the accuracy score (MSE). The components of C, Fe, Si, and the immersion time acted as more important when they were shuffled, and they showed a great drop in the MSE of the E_{corr} model. Furthermore, as a game theoretic approach, SHAP can interpret the output of machine learning models by the classic Shapley value. A feature's positive SHAP value enhanced the properties, while conversely, a negative SHAP value for a feature weakened the properties.

Figure 6b shows how each feature affected the GBR model output of E_{corr}, where the features are shown in descending order according to their importance by the average absolute value of all features' SHAP values. The components of Si, Fe, C, and immersion time also acted as the most important factors for E_{corr} prediction. For element Fe in Fig. 6b, the SHAP value was positive when increasing the component of Fe, which indicated that the addition of Fe would enhance E_{corr} (the output of the model was kept stable). For the immersion time, it was obvious that a longer immersion time would weaken E_{corr} (the output of

the model tended to descend).

Overall, the two feature importance analysis methods based on different mechanisms both considered Fe, C, Si, and the immersion time to be most important for Ecorr, although they differed slightly in the importance order of Si. For the duplex stainless steel Zeron 100, Fe was the main element and C was 0.03%, while for the three cobalt-based alloys, Co was the main element, the content of Fe element accounted for 2–3%, while the content of C was greater than 1%. The pitting corrosion resistance of Zeron 100 was significantly better than the cobalt-based alloys. Therefore, the composition of the alloys was significantly different, resulting in the higher importance of these three elements. It is worth noting that the immersion time had an obvious influence on the E_{corr} prediction by GBR (from Fig. 6b), indicating that the local corrosion states of the previous sequence were inherited into the prediction of the subsequent sequence and the cumulative effect over time dimension needs to be utilized.
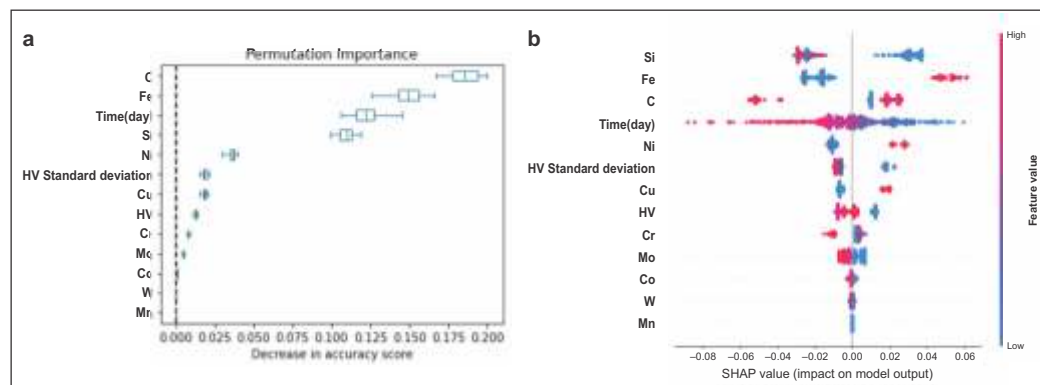

Fig 6: Feature importance analysis for GBR model. Feature importance as given by the permutation importance and SHAP value based on the GBR E_{corr} model: a Box plot of the feature contributions by permutation importance with the minimum and maximum score, lower and upper quartile, and mean value of various features versus its decrease in accuracy score of models; b Distribution plot of the feature contributions by the SHAP value. High feature value is colored with red and low feature value is colored with blue. GBR gradient boosting regression, SHAP Shapley Additive exPlanations.
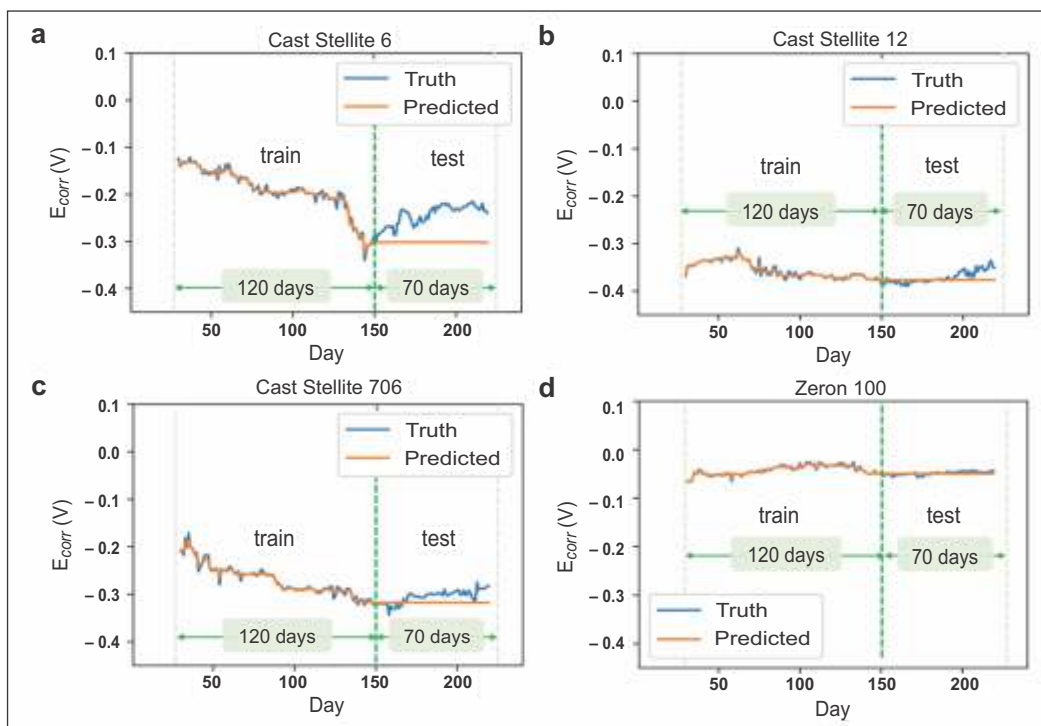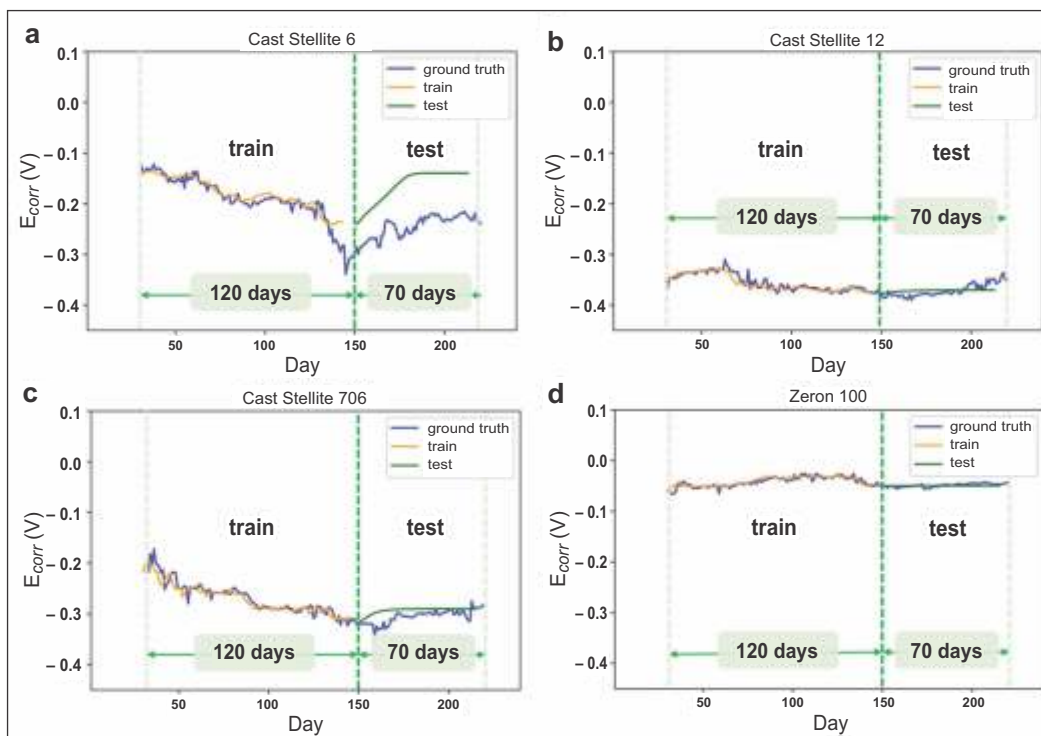
Fig 7: The prediction of following 70 days' immersion by GBR model. Prediction of the following 70 days of immersion by the GBR model: a Cast Stellite 6, b Cast Stellite 12, c Cast Stellite 706, and d Zeron 100. GBR gradient boosting regression, E_{corr} free corrosion potential.

The prediction following 70 days of immersion

To validate the analysis results and estimate the E_{corr} of unseen immersion, additional 70-day immersion tests were carried out based on the previous experiment and the E_{corr} was measured each day. We utilized the pre-built E_{corr} models of GBR and LSTM to predict the following 70 days of pitting evolution. Figure 7 describes the training (120 days) and testing (70 days) stages by the GBR model for cast Stellite 6, cast Stellite 12, cast Stellite 706, and Zeron 100. Although the predicted values and the ground truths fit well in the training stage, in the subsequent 70-day testing stage, the GBR model gave fixed predicted values of the four alloys, which did not match the evolution trend of E_{corr}. This indicated that traditional statistical analysis methods such as GBR defaulted to the assumption of independent and identical distribution among the data samples. For dynamic pitting evolution, it could not make use of the inherent time-series relationship between the data samples.

Figure 8 shows the prediction of the following 70 days of immersion by the LSTM model. Compared to the GBR model, the time-series model fit the trend of E_{corr} well, especially in the testing stage (green plot in Fig. 8). The absolute deviation between the predicted value and the ground truth was somewhat large for cast Stellite 6, which was mainly due to the significant increase in E_{corr} around day 150 (the dividing line between the training and testing stages). For the cast Stellite 12, 706, and Zeron 100 alloys, the absolute deviations between the predicted and ground truths at the testing stage were smaller. This indicated that the LSTM model could capture the inherent time-series relationship between the data samples and could be utilized in long-term pitting evolution prediction.

In summary, by taking cobalt-based alloys and duplex stainless steel as the case

Fig 8: The prediction of following 70 days' immersion by LSTM model. Prediction of the following 70 days of immersion by the LSTM model: a Cast Stellite 6, b Cast Stellite 12, c Cast Stellite 706, and d Zeron 100. LSTM long short-term memory, E_{corr} free corrosion potential.

Alloys	Co	Cr	W	Mo	Fe	C	Ni	Si	Mn	Cu	HV	HV standard deviation
Cast Stellite 6	58.4	28.9	4.5	0	2.4	1.2	2.5	1.1	1	0	496.6	25.145
Cast Stellite 12	52.6	29	8.5	0	3	1.4	3	1.5	1	0	504.2	40.25
Cast Stellite 706	50.3	27	0	5	2	1.2	3	10.5	1	0	465	21.722
Zeron 100	0	26	1	4	57.47	0.03	8.5	1	1	1	362.5	13.199

Table 1 Chemical compositions (wt.%) of the experimental material.

scenario, we explored a time-series-based machine learning method for predicting the pitting evolution behavior by LSTM. We constructed a pitting evolution model to predict E_{corr} under immersion testing in saline during 150 days in the propagation stage. The traditional machine learning model GBR was compared with LSTM, which did not fit well in the evolution trend of E_{corr} during the subsequent 70-day unseen testing stage. The LSTM model was more consistent with the evolution trend of the ground truth from experimen-tation, which illustrated that this method could capture the inherent time-series relation-ship between the data samples and could be utilized in long-term pitting evolution prediction. This work may provide a promising avenue for time-series sequence prediction, which could be further generalized for other material service and lifetime behavior predictions.

Methods

Data collection

All of the data used in this work were obtained by experiments in laboratory, including four different alloys: Stellite 6, Stellite 12, Stellite 706, and Zeron 100. The nominal chemical composi-tions of each material are shown in Table 1.

The samples were prepared by casting and were embed-ded in epoxy resin with a wire soldered to the rear. The surfaces were polished using 80, 240, 600, and 1200 grit SiC paper and then polished using 6-micron diamond paste. The hardness of these materials was also measured up to 50 times for each sample. Long-term immersion tests were conducted in 3.5 wt.%NaCl solution at 18°C for 150 days.

Machine learning metrics

Mean squared error (MSE) was used as a metric for the error between the ground truth and predicted value under each hyperparameter, and MSE could be calculated by

$$MSE = \frac{\sum_{i=1}^{N} (\hat{y}_i - y_i)^2}{N},\quad(1)$$

where N is the total number of the dataset, and y_i and $y_{i'}$ represent the ground truth and predicted value of the ith data entry, respectively.

Moreover, to evaluate the generalization capability intuitively, mean relative error (MRE) was also calculated on both the training and testing sets. MRE is defined by Eq. (2):

$$MRE = \frac{\sum_{i=1}^{n} \left| \frac{\hat{y}_i - y_i}{y_i} \right|}{N},\quad(2)$$

where N is the total number of the dataset, and y_i and $y_{i'}$ represent the ground truth and predicted value of the ith data entry, respectively.

Traditional machine learning models

Support vector regression (SVR), k-nearest neighbor regression (KNR), gradient boosting regression (GBR), random forest regression (RFR), and AdaBoost regression (AdaBR) were used based on the Scikit-learn machine learning library. Parameter tuning was performed to obtain the optimal model parameters. The whole dataset from all types of concerned alloys was randomly split with 80% as the training set (384 data entries) and 20% left as the testing set (96 data entries). Parameter tuning was employed on the training set using grid search by five-fold cross-validation with ran-domly selected hyperpara-meters for each machine learning algorithm. The mean and variance of the five-fold MSEs were calculated to evaluate the comprehensive performance of all hyperpara-meters for each algorithm.

LSTM neural network

The internal structure of LSTM comprises the forget gate, input gate, and output gate. LSTM can use memory cell c_t to remove or add information. c_t is composed of the input gate i_t, forget gate f_t, and output gate o_t. First, LSTM decided what information would be discarded from the cell state by the forget gate. The previous sequence's hidden state h_{t-1} and current data X_t are simultaneously input into the forget gate f_t. The forget gate's output represented the probability of forgetting the information provided by h_{t-1}, as given in Eq. (3):

$$f_t = \sigma(W_f * [h_{t-1}, X_t] + b_f),\quad(3)$$

where W_f, b_f, and σ are the linear correlation coefficient, bias, and sigmoid activation function respectively. The value of f_t is between 0 and 1, where 0 indicates that no information can pass, and 1 indicates that any information can pass.

The input gate determines how much new information is stored in the cell state, which consists of two parts, namely, it and $\hat{c}_t$, where it utilizes the sigmoid activation function (Eq. (4)) and $\hat{c}_t$ utilizes the tanh activation function (Eq. (5)):

$$i_t = \sigma(W_i * [h_{t-1}, X_t] + b_i),\quad(4)$$

$$\hat{c}_t = tanh(W_c * [h_{t-1}, X_t] + b_c),\quad(5)$$

where W_i and W_c represent linear correlation coefficients, and b_i, and b_c represent biases.

The results of i_t and $\hat{c}_t$ had to be multiplied to update the old cell state c_{t-1} to new c_t. The old state c_{t-1} was multiplied by f_t to discard the information that would certainly be discarded, and then added by the product of the input gate i_t and $\hat{c}_t$, as Eq. (6). For the output gate o_t (Eq. (7)), the sigmoid activation function was used and W_o and b_o indicated the correlation coefficient and bias. The hidden state h_t was finally updated by the product of o_t and c_t after the activation function tanh (Eq. (8)), according to:

$$c_t = f_t * c_{t-1} + i_t * \hat{c}_t\quad(6)$$

$$o_t = \sigma(W_o * [h_{t-1}, X_t] + b_o),\quad(7)$$

$$h_t = o_t * tanh(c_t).\quad(8)$$

The LSTM neural network was implemented by TensorFlow and Keras after transforming the original dataset to a set of training sequences with a sliding window, namely the lookback window. We carried out parameter tuning of the lookback window for the LSTM neural network, where we transformed the 120 days of data entries of the 4 alloys into time-series sequences with lookbacks of 3, 5, 8, and 15. For each lookback length, the LSTM neural network was trained on the first 80% sequences as the training set and tested on the remaining 20% sequences as the testing set to evaluate the generalization ability for individual dataset related to each type of alloy. Taking Cast Stellite 6 alloy as an example, the architecture of the LSTM neural network for the cast Stellite 6 alloy consisted of an input layer with 5 units (e.g., lookback = 5), 3 hidden layers with 128 units, and a fully connected layer with 1 unit and a 'relu' activation function as the output layer. Except for the output layer, dropout was used to prevent the neural networks from overfitting. The MSE metric was applied as a loss function and the network was optimized by the 'Adam' stochastic optimization algorithm. The hyperparameters were also tuned, including the number of hidden layers and units, batch size, and dropout.

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Indian Railways and SAIL working together on corrosion free steel production

India focussing on 300 million ton annual steel production by 2030

Addressing the fourth Global Zinc Summit in New Delhi recently, Union Minister of Steel and Civil Aviation Shri Jyotiraditya Scindia stated that Indian Railways and Steel Authority of India Limited (SAIL) are working together to produce corrosion free steel. Shri Scindia added that at present India is the fourth largest producer of zinc in the world and 80% of zinc produced in India is consumed domestically. With anti-corrosion features and quality to prevent oxidation in steel products, zinc has tremendous marketing potential for sectors like renewable energy, rural electrification, galvanizing the structure in smart cities etc. Galvanized steel will give long life to infrastructure made in our long coastal line, he added.

Touching upon the crucial strides made by India's steel sector, Shri Scindia stated that large scale augmentation will be done to double production from present capacity of 150 million tonnes per annum to 300 million tonnes per annum by 2030. India has already emerged as the second largest steel producer in the world and our per capita steel consumption has gone up from 57kg to 78kg during the last nine years, Shri Scindia said.

The Minister said that we have awarded 54 applications submitted from close to 26 companies under the Production Linked incentive (PLI) for specialty steel. The Union Cabinet in July 2021 approved a Rs 6,322-crore PLI scheme to boost the production of speciality steel in India. The PLI will help to extent production capacity of 26 million ton per annum and investment of Rs 30,000 crore with the employment generation for 55,000 people. The Minister added that government has announced a huge capex of Rs 10 lakh crore for infrastructure development which has opened tremendous investment opportunities across the sectors.

Highlighting the Prime Minister's commitment to net zero carbon emission by 2030, the Steel Minister said, "we have to learn to coexist with the environment, we have to learn to respect the environment, there can no longer be a linear model of take, make and dispose. Recycling has to become a part of our existence".

Member of Parliament Shri Raju Bista, Shri Arun Misra CEO, HZL, Dr Andrew Green, ED, IZA and Delegates from Europe, America and Asia were present in the program, the press release from the Press Information Bureau stated.

At another event, addressing the Chintan Shivir organized by the Ministry of Steel, Shri Scindia, urged the stakeholders in the steel sector to adapt new ideas, innovations, and new technologies to fast track the steel sector. He stressed the importance of team spirit, motivation, consistency, and constant learning to enhance the capacity and capability to improve the quality of output. "Leadership is all about compassion, empathy, love, and a caring attitude that helps the institution to achieve its goals. The soft skills aspect plays a key role in the success of a person or institution," Shri Scindia added.

Shri Scindia lauded experts' perspectives on raw material issues of steel industry as well as the Industry's contribution to the circular economy. He stressed the need for reverse logistics in steel sector. There was a need to identify pathways of generation and recovery of scrap, both in the organised and unorganized sectors and formulate policies and structures to enhance the intensity of circularity in the country, said the Minister.

He stated, "We are also ready to meet the challenges of fulfilling the increasing demand for steel products and increasing the production of steel for the development of the nation."

Union Minister of Steel and Civil Aviation Shri Jyotiraditya Scindia addressing the fourth Global Zinc Summit in New Delhi.

Gold-based coating prevents fogging in eyewear, car windshields

Researchers at ETH Zurich have developed an ultrathin, gold-based transparent coating that is able to convert sunlight into heat. It can be applied to glass and other surfaces to prevent them from fogging, notes a press communique from the University. Applications for the new coating include eyewear, car windshields.

Researchers in the group led by ETH Professors Dimos Poulikakos and Thomas Schutzius point out that their coating is fabricated with methods which are used extensively in manufacturing. In a clean room and using vapor deposition under vacuum, minute amounts of gold are deposited onto the surface. ETH Zurich has applied for a patent on the coating.

What's special about the new coating is that it absorbs solar radiation selectively. Half of the energy contained in sunlight resides in the infrared spectrum, the other half in the visible light and UV radiation spectrum. "Our coating absorbs a large proportion of the infrared radiation, which causes it to heat up – by up to 8 degrees Celsius," explains

ETH doctoral student Iwan Hächler, who was a driving force behind the development. It absorbs only a minor fraction of the radiation in the visible range, which is the reason why the coating is transparent.

The new coating takes an approach that differs from conventional antifogging methods. Traditionally, surfaces are coated with water-attracting (hydrophilic) molecules, which results in an even spread of condensation. This is how antifog sprays work. But the new method instead heats the surface, thus preventing humidity-induced condensation from forming there in the first place. It's the same principle as is used for a car's rear window. But, as Hächler points out, electric heating is inefficient and energy wasteful. In contrast, the new coating is heated passively and requires, during daytime, no additional energy source.

Poulikakos, Schutzius and their teams have been working on passively heated surface coatings for several years. Three years ago, the scientists published their first research paper on a gold

Close-up of man's face. His left lens has the new anti-fogging nanocoating. The other lens is uncoated.

coating that prevented transparent surfaces from fogging up. The coating they have now presented has many benefits over the first: It is made up of a single gold nanolayer and is significantly thinner, which makes it more transparent as well as pliable. Further, it is also more transparent and efficient because it absorbs infrared light more selectively.

Gold might be expensive, but the researchers emphasize that their coating requires so little that the material costs remain low. The coating comprises minuscule, extremely thin clusters of gold sandwiched between two ultrathin layers of titanium oxide, an electrically insulating material. Due to their refractive properties, these two outer layers increase the efficacy of the heating effect. Moreover, the top layer of titanium oxide acts as finish that protects the gold layer from wear. This whole "sandwich" is just 10 nanometres thick. By way of comparison, a common gold leaf is twelve times thicker.

The individual gold clusters touch each other minimaly, which is what allows the gold layer to just start conducting electricity. So in the absence of sunlight, it would still be possible to use electricity to heat the coating.

The researchers will now develop the coating further for other applications. In the process, they will investigate whether other metals work just as well as gold. In addition to eyewear and windshields, this antifogging method could be used wherever objects must be both heated and transparent – such as windows, mirrors or optical sensors. There is no need to fear, however, that this would cause a car or a building to heat up more in the summer. ETH doctoral student Hächler explains: "The pane coating absorbs infrared rays from the sun, which specifically heats the pane and prevents the radiation from reaching the inside of the car or building. As a result, the interior heats up even less than it would without the coating."
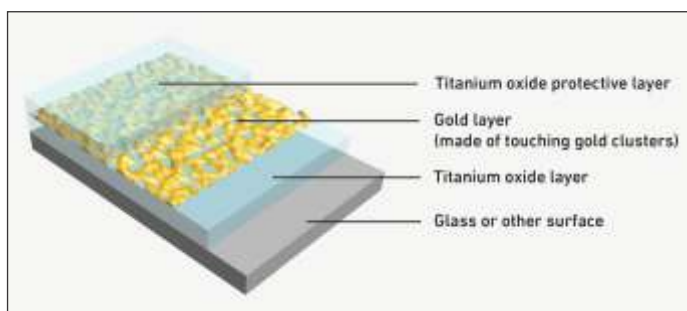
An illustration of how the glass no longer fogs up. It consists of 4 layers, a titanium dioxide protective layer, a gold layer, a titanium dioxide layer and the glass.

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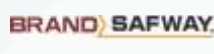
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New biomaterial coating to tackle packaging waste pollution

Flinders University materials researchers and pioneering German biomaterials developer one•five are using seaweed extracts to develop next-generation biopolymer coating materials that could solve packaging waste dilemmas for the fast-food industry.

The new non-pollutive biomaterials are designed to replace conventional fossil-based plastic coatings used in grease-resistant fast-food packaging, notes a press release from the University.

Grease-resistant paper is typically coated with plastic and other environmentally harmful chemicals, such as polyfluoroalkyl substances (PFASs), but the new prototype coating meets the functional requirements of conventional grease-resistant packaging materials while also presenting an environmentally circular solution.

The result represents a landmark achievement in creating next-generation sustainable and ecologically responsible biopolymer.

"We are able to reduce harmful plastic pollution with this product, and we are also using feedstock that is environmentally regenerative," says Claire Gusko, one•five Co-Founder.

"Seaweed cultivation helps to naturally rehabilitate marine environments, reduce greenhouse gases, and mitigate coastal erosion. It's important for us to use sustainable inputs upstream to ensure our products are environmentally safe, from cradle to grave."

This development – which took extracts from certain seaweeds, added modifications and formed degradable bioplastic films – has been led by Dr Zhongfan Jia, a lead researcher from the Flinders
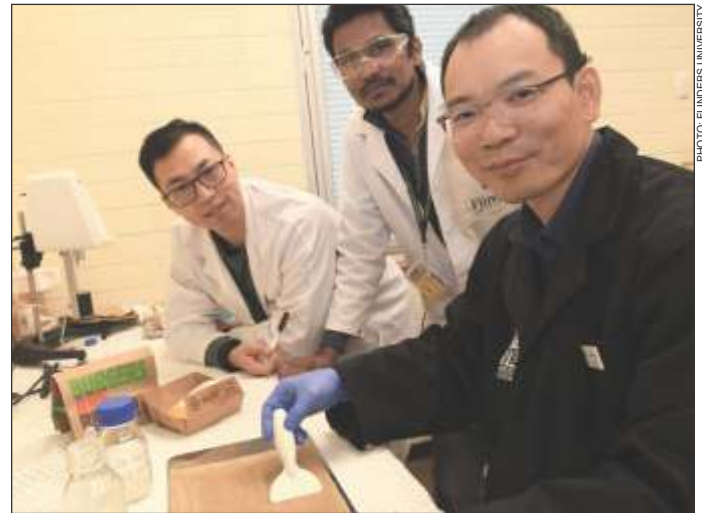
Flinders University researchers Peng Su, left, Chanaka Mudugamuwa and Dr Zhongfan Jia testing the biopolymer coating for potential use in fast-food and other wrappers.

Institute for Nanoscale Science and Technology and research colleague Mr Peng Su in association with the Flinders Centre for Marine Bioproducts Development.

"The seaweed extracts have a similar structure to the natural fibres from which paper is made," says Dr Jia. "Our novel specialist treatments boost the grease-resistance feature of the seaweed via simple modifications while not affecting biodegradability nor recyclability of the coated paper."

Biomass for the new coating formulation is made from natural polymers

extracted from seaweeds that are native to the South Australian coastline – which provided a key reason why the Flinders University researchers studied it for more broad scientific application.

These extracts are transformed through a proprietary processing methodology to produce functional biopolymer sheets that can be cut or coated onto various surfaces, depending on the application.

Flinders University and one•five are now working towards transferring laboratory-scale processing to produce industrially-relevant volumes of the natural polymer coating.

This initiative aims to have a transformative impact on the global packaging and plastics industry by significantly reducing reliance on highly pollutive conventional plastic.

The initiative aims to have a transformative impact on the global packaging and plastics industry by significantly reducing reliance on highly pollutive conventional plastic.

Chemical researchers discover catalyst to make renewable paints and coatings

A team led by the US-based University of Minnesota, researchers has invented a groundbreaking new catalyst technology that converts renewable materials like trees and corn to the key chemicals, acrylic acid and acrylates used in paints, coatings and superabsorbent polymers. The new catalyst technology is also highly efficient, which means lower costs for manufacturing renewable chemicals.

The new catalyst formulation converts lactic acid-based chemicals derived from corn to acrylic acid and acrylates with the highest yield achieved to date. The technology exhibits substantially higher performance when benchmarked against other classes of leading catalysts.

The research is published online in the *Journal of the American Chemical Society Gold* (JACS Au).

Acrylic acid and associated acrylates are best known through their uses in everyday items from paints and coatings to sticky adhesives to superabsorbent materials used in diapers. These chemicals and materials have been made for the last century from fossil fuels. But in the last few decades, the corn industry has been growing to expand beyond food and livestock feed to manufacturing useful

chemicals. One such corn-derived chemical is sustainable lactic acid, a key ingredient in the manufacturing of the renewable and compostable plastic used in many everyday applications.

Lactic acid can also be converted to acrylic acid and acrylates using catalysts. However, until this new catalyst discovery, traditional catalysts were very inefficient and expensive.

"Our new catalyst formulation discovery achieves the highest yield to date of acrylic acid from lactic acid," said Paul Dauenhauer, a professor in the University of Minnesota College of Science and Engineering. "We benchmarked the performance of our new catalyst to all prior catalysts, and the performance far exceeds previous examples."

The new catalyst formulation substantially reduces the cost of manufacturing renewable acrylic acid and acrylates from corn by improving yield and reducing waste. For the first time, this could reduce the price of renewable acrylic acid below fossil-derived chemicals.

The new catalyst formulation substantially reduces the cost of manufacturing renewable acrylic acid and acrylates from corn by improving yield and reducing waste.

The research team plans to continue their basic research on catalyst design to understand the fundamental aspects of the chemistry with financial support from the Center for Sustainable Polymers.

"This is a wonderful example of how addressing important basic research questions that are at the heart of fundamental catalysis can lead to innovative new processes that have true technological promise," said Marc Hillmyer, director of the Center for Sustainable Polymers and a professor in the College of Science and Engineering. "A grand challenge in the Center for Sustainable Polymers is the efficient and sustainable conversion of biomass to polymer ingredients, and this work represents a groundbreaking solution to that challenge that will have

lasting impact."

The research team was supported by the U.S. National Science Foundation through the NSF Center for Sustainable Polymers, a multi-university collaborative team with a mission to transform how plastics are made, unmade and remade through innovative research.

The University of Minnesota College of Science and Engineering brings together the University's programs in engineering, physical sciences, mathematics and computer science into one college. The college is ranked among the top academic programs in the country and includes 12 academic departments offering a wide range of degree programs at the baccalaureate, master's, and doctoral levels. Learn more at cse.umn.edu.

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JUN 26 – 28, 2023	COATINGSTECH CONFERENCE 2023	Hyatt Regency Cleveland at the Arcade, Ohio, USA	American Coatings Association	W: paint.org
JUN 29 – JUL 01, 2023	CII SURFACE & COATING EXPO 2023	Chennai Trade Centre Chennai, India	Confederation of Indian Industries	T: (044) 42444555 E: surface.coating@cii.in W: ciisce.in
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