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Quality control and new product development in the automotive industry have great importance. AZoM talks for Dr. Evans Mogire from Buehler about how they are leading the way in answering the challenges set by the automotive industry regarding testing materials.

We recently spoke to Dr Mike Keeble about what Buehler offers the aerospace industry. Please could you tell us about what Buehler provides to the automotive industry?

As Dr. Keeble recently pointed out, Buehler is a world-wide premier manufacturer of equipment and supplies for materials preparation and analysis. We pride ourselves in having close knit relationship through the technical support we provide and collaborative solution finding with our Industrial and research partners in automotive sectors.

realised, materials sample preparation and analysis has become a key ingredient for developmental feedback that calls for consistency, repeatability and reproducibility of test results. What Buehler does is to look at these challenging needs and requirements and continually develop equipment and related methodologies to match these needs.

The automotive industry has seen increased development in materials over recent years aimed at improving performance, weight and strength. What sets Buehler apart from other companies when testing these materials?

Our rich and strong historical background in materials preparation allows us to dissect and disseminate best practices in metallographic preparation in a consistent and dependable manner. As Dr. Keeble also highlighted before, we do have an excellent network of application specialists from a wide variety of backgrounds working together as a global team to address existing and new challenges in automotive materials preparation.

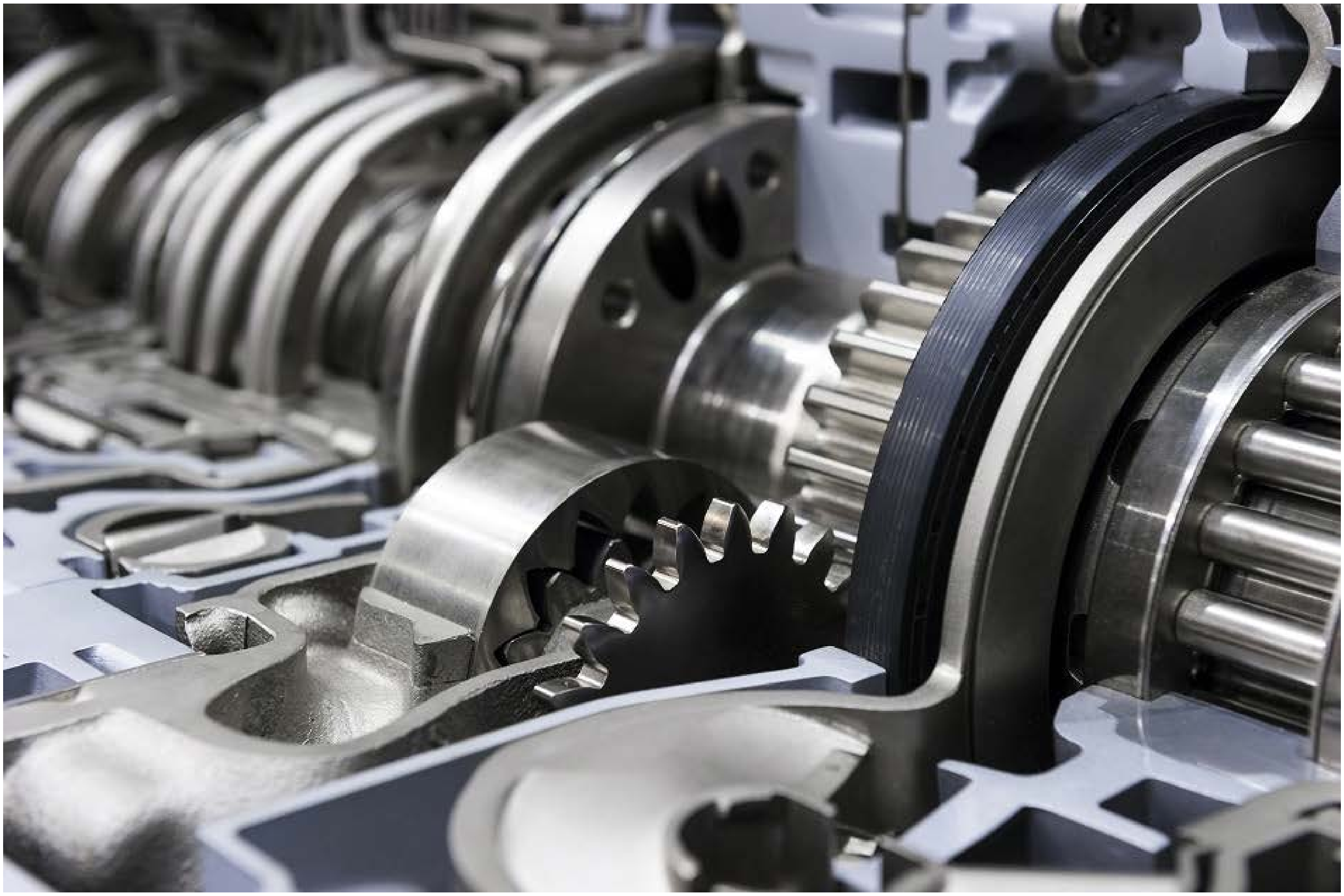
We have also collaboratively partnered with High Value Manufacturing Catapult centres across the United

Kingdom, such as Manufacturing Technology Center (MTC), National Composites Center (NCC), Warwick manufacturing group (WMG) among others actively involved in automotive and aerospace sectors. I am based within Warwick manufacturing group, where we have set up a Buehler Solutions Centre that serves to offer solutions on metallographic preparation at the forefront of new technological developments.

Furthermore, some of our clients consider Buehler a partner as opposed to a classic equipment supplier. We actively engage in solution finding with our clients, who include us in the development and optimisation of their operating practices by leveraging our extensive know-how of different applications in automotive metallographic preparation.

What changes have you seen in the automotive industry in terms of materials analysis and testing? How has Buehler adapted to meet these changes?

The changes I have observed in materials analysis in the automotive sector have been mainly driven to address; the ease with which testing equipment can be used, how quickly can materials testing be done, and how repeatable and reproducible are the test results. This is more critical for production/quality control environments as opposed to research and development environments where speed might not necessarily be critical but repeatability and reproducibility of testing is crucial.



At Buehler, understanding different requirements for production versus a research and development environment has been integral to the solutions we provide. Increasingly we are seeing requests for automated operating procedures that require lower man hours for the same output. We believe our approach of semi-automating optimised metallographic processes addresses these challenges, and as a consequence, a significant reduction in man-hours required for testing whilst achieving high quality results. For example, incorporating dedicated semi-automatic workstations for particular stages in metallographic preparation sequence and adopting “in-lining” optimisation techniques. This offers opportunity to monitor progress in the preparation sequence, enabling corrective measures to be taken when needed without wasting time.

What materials do you typically test?

The list of materials that we typically test can be quite extensive. The main materials found in automotive can be categorised to those relating to the vehicle structure and the powertrain. The materials found on vehicular structure include steels, structural aluminium alloys and composite materials and for powertrains include various grades of steels for engine and transmission components, aluminium and it alloys for castings and magnesium alloys among others. For the power trains for hybrid electric vehicles (HEV) and fully electric vehicles (EV), tests are predominantly on electrical steels for the motor drives, battery pack materials and analysis of different welding techniques during battery pack manufacture, fuel cell materials and its multilayer construction analysis.

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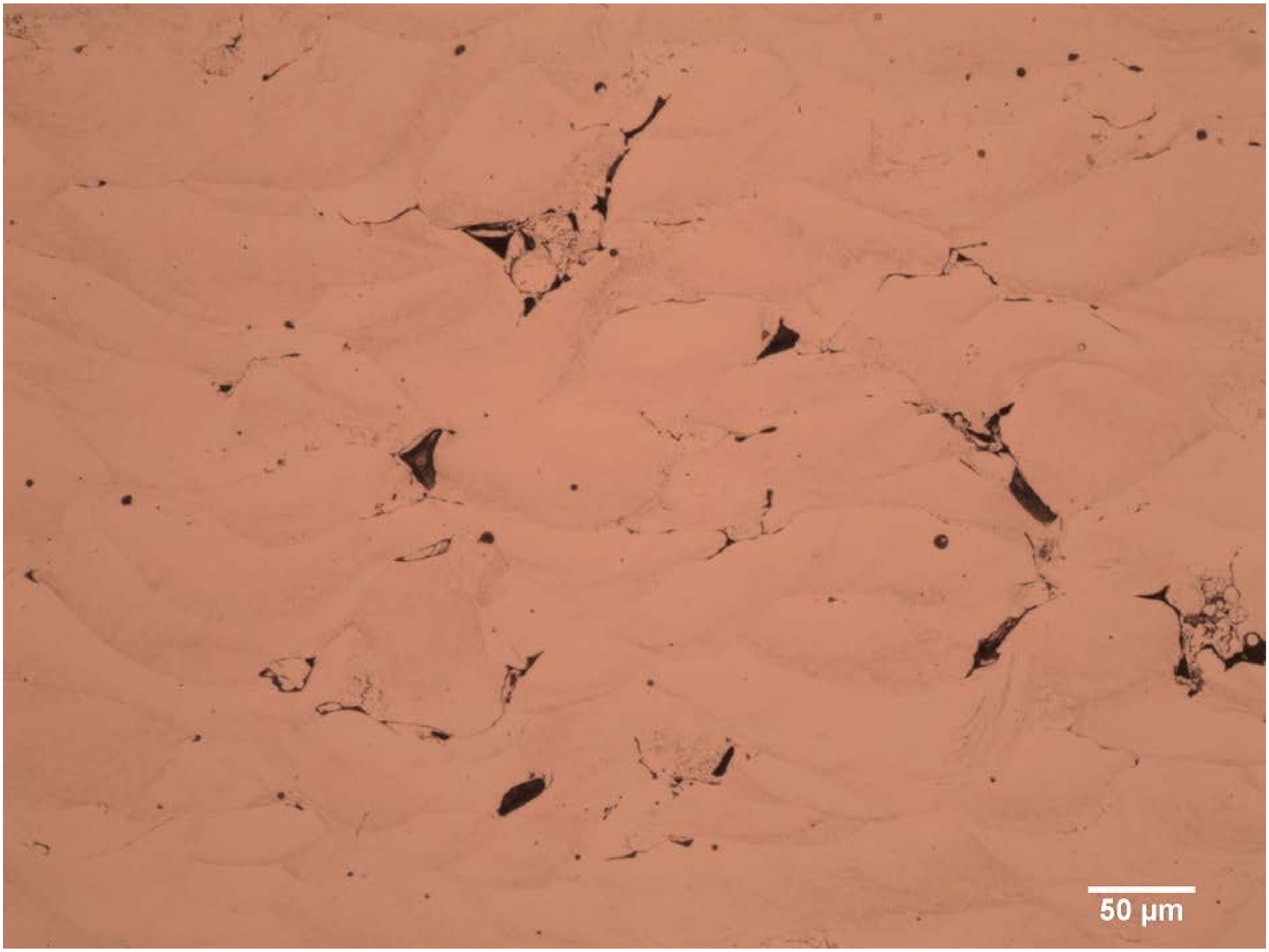
Are there any materials or component materials where significant developments have taken place as a result of the materials testing solutions you provide?

A key area is the use of additive manufacturing techniques of various components ranging from powertrain, frame and body parts, electronics, wheels, tires and suspension and interior body works. The technique of manufacture depends on the type of feed stock used, this is predominantly metallic such as aluminium, nickel and cobalt based superalloys, titanium and steel alloys and polymerics such as engineering polymers including nylon (PA 11, filled PA12 or P6), PEK and PEEK among others. At Buehler we've worked with a number of companies actively involved in developing and optimising laser beam melting additive manufacturing techniques, with whom we've collaboratively developed metallographic preparation procedures to characterise these materials and provide feedback for laser process optimisation.

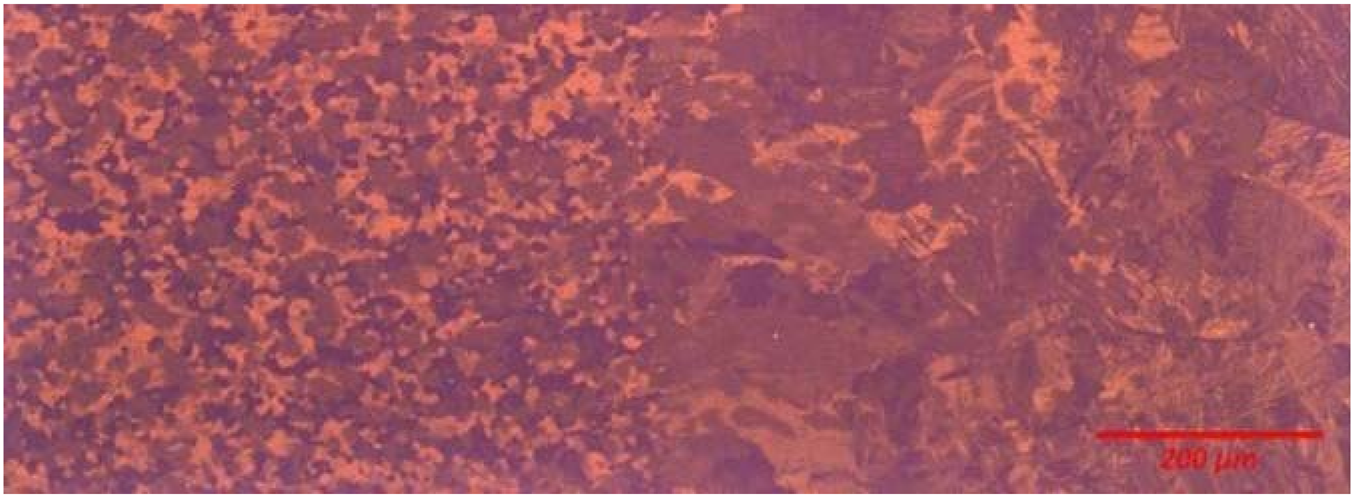


Copper AM manufactured component

We've also been proactive in sample preparation of laser beam welded aluminium panels of common thicknesses found in automotive body panels, with the intent of optimising laser beam energy and speed of traverse, which affect the quality of the resultant welds. Also by providing alternative methodologies for microstructural investigation using anodization techniques, with benign chemicals, to aid with optical characterisation of Al alloys microstructures.

Are there any recent case studies from the automotive industry that you are particularly proud of?

A typical case study involved developing preparation procedures for metallographic inspection of induction hardened crank journals and sprocket areas of an automotive crank shaft. The requirement from our client was for speed of preparation and excellent quality of resultant microsections. The cranks are made from carbon steel that undergoes induction hardening at the journal and sprocket areas for improved durability, by increasing the surface hardness through phase transformational microstructural changes compared to the core areas that remains unaffected by the treatment. We developed a semi-automatic preparation sequence with dedicated single task work stations optimised for in-lining for smooth and faster preparation, but also allowing operators to visually check between stages (feedback loop) and do corrective actions if needed. We also looked at subsequent indentation hardness testing processes, the number of samples that would need testing and how we can optimised the previous stages to enable high throughput with minimal downtime. Our expertise as a metallographic and indentation hardness testing equipment manufacturer and solution provider proved a winning combination to meet this high volume inspection requirement.

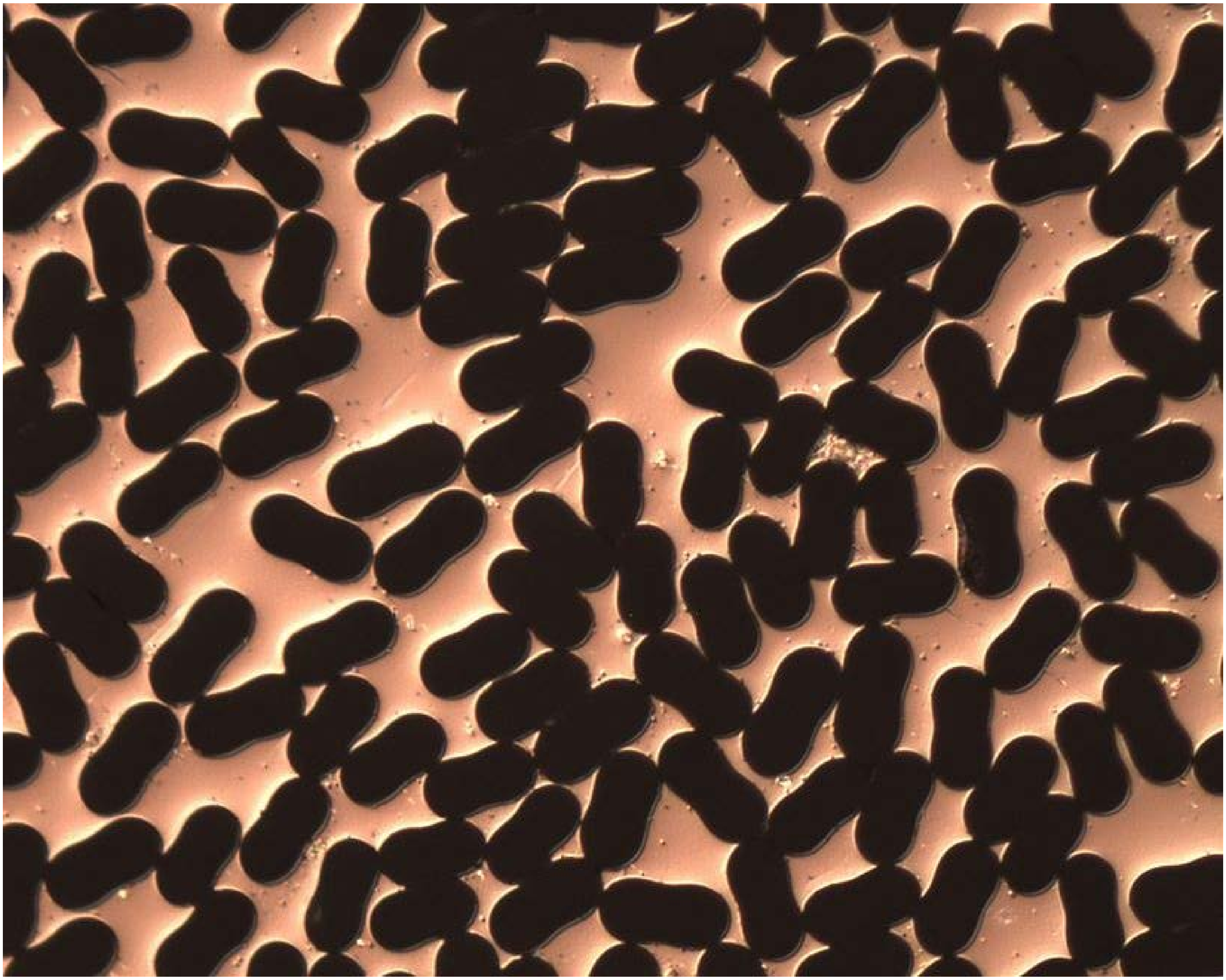


Laser welded titanium alloy

I am also proud of the work we’ve carried out on metallographic preparation of metal matrix composite (MMC) systems used in various components in the powertrain and vehicular structures. MMC’s are metallic materials reinforced with a high performance material, with the latter being in fiber or particulate form. As a system, the resultant MMC exhibits high strength, high stiffness and improved durability (through wear resistance, self-lubricating and self-healing) from the reinforcement material whilst retaining a low weight final component relative to the improved properties. The reinforcement is generally a harder phase, such as silicon carbide, alumina, TiB2, boron nitrides, carbon nanotubes among others, whereas softer reinforced are also added such as graphite based addition for lubricity. These are typically more brittle or softer than the underlying matrix, presenting a considerable challenge of not damaging either phase during metallographic preparation. An example is in the manufacture of pistons and cylinder liners now increasingly made of MMC, made up of aluminium reinforced with graphite particles, porous silicon preforms, alumina and carbon fibres for improved wear behaviour through lubricity and better cooling efficiency. These have the added advantage that they can be cast in place using traditional casting processes. Metallographic inspections aid with understanding the interfacial behaviour of the reinforcement with the matrix, thus preparation methodologies used should result in the observation of a true microstructure free from smearing of the softer matrix around this interface.

How do you see materials testing moving forward in the automotive industry over the next 10 years?

Technology is rapidly changing in the automotive sectors, this is driven by environmental concerns such as the need for low CO_2 and NO_x emitting cars, improved thermal efficiencies through hybrid electric vehicles or fully electric cars from the powertrain side and the need for cradle to grave design through proper material selection for design and the ease of recyclability at the end of life. Both approaches demand new and recyclable material are used without compromising safety. From a structural view point, more focus will be on light weight structures made from carbon fiber composites with or without metallic reinforcements and increasingly use of thermoplastics as opposed to thermosetting resin. Thermosetting polymers typically have longer cure times compared to thermoplastics but more rigid in comparison and can be molded with rib like structures to improve their stiffness. For metallic structures, the joining methodologies will also be of interest such as laser welding and/or adhesive bonding of materials and related technologies. On the power train side, hybrid/electric vehicles (HEV) will continue to grow and gain more market share from traditional internal combustion engines (ICE). For HEV, improvement in battery pack manufacture and related thermal management architectures due to the charging and discharge cycles as well as improvements in motor drive materials for efficiency and lifecycle viewpoint. For ICE’s, emphasis on thermal efficiency improvement through incorporation of MMC’s as previously discussed and exhaust architecture design to remove harmful particulate will all call for improved component macro and micro inspections and analysis.



Metal matrix composite consisting of alumina fibers in aluminium casting alloy.

At the core of these changes, there will always be metallographic preparation and testing. With emphasis being on intuitive and easy to use testing equipment, more opportunities for semi-automatic preparation of materials that allow users to proactively have a means of checking progress and making corrective actions just in time.

Where can our readers learn more about Buehler and what you offer the automotive industry?

Our website www.buehler.com offers insights on automotive related metallographic preparation. You can find related case studies and information on various equipment and consumables. You will also find contact details of our application experts for additional information based on your geographical location.

About Evans Mogire

Dr. Mogire graduated from Loughborough University with an MSc in materials engineering and a PhD in high temperature oxidation and microstructural degradation of power plant materials investigating low alloy steels, medium alloy steels, austenitic stainless steel and nickel based alloys. After his studies, Evans worked as a metallurgist in the Boiler Metallurgy and Structural Integrity group for Doosan Babcock, involved with metallurgical condition assessment of high temperature and high pressure components in power plants and petrochemical refineries, weld research and development, and failure analysis of in-situ and ex-service components.

Evans currently holds the position of EMEA Technical and Laboratory Manager at Buehler, based at one of the world-wide solution centres in Coventry, United Kingdom, where he provides technical support and training on metallography for Europe, Middle East and Africa markets. Evans also holds a Visiting Academic position at Warwick University supporting PhD researchers as well as research staff within the Warwick Manufacturing Group. Evans is also an active member of IOM3 Structure and Properties of Materials committee, a fellow of the Royal Microscopical Society (RMS) and a technical member of ISO standards organisation (BSI) for indentation hardness testing.

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In this interview, Dr S. Amini, post-doctoral researcher at the Max Planck Institute of Colloids and Interface, talks to AZoM about his work involving the structural properties and mechanical responses of teeth enamel.

Related ANSI Standards

ASTM C565-15: Standard Test Methods for Tension Testing of Carbon and Graphite Mechanical Materials

ASTM C808-75(2016): Standard Guide for Reporting Friction and Wear Test Results of Manufactured Carbon and Graphite Bearing and Seal Materials

ASTM C748-98(2015): Standard Test Method for Rockwell Hardness of Graphite Materials

ASTM C24-09(2013): Standard Test Method for Pyrometric Cone Equivalent (PCE) of Fireclay and High Alumina Refractory Materials

ASTM E110-14: Standard Test Method for Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers

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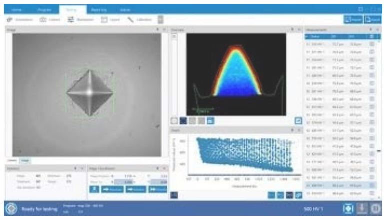

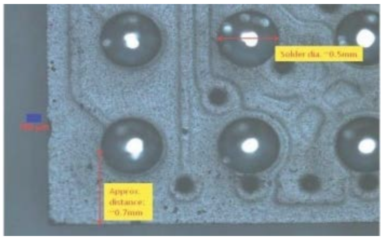

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