Metals Analysis
Five things that could figure in your future

From the rise of robots in the manufacturing process to the fall in quality of raw materials from certain sources, our industry has never been a more challenging place to operate. And yet it's never been more interesting and exciting either.

Here's just a few of the issues that keep us talking at Hitachi High-Tech; highs and lows that are influencing the way we develop our technology to ensure that the future for those working with metals is a successful one.

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1.3D Printing in metal

Imagine you're standing on a futuristic-looking 12-metre-long steel bridge across an Amsterdam canal. It's a beautiful evening. Swans swim silently underneath you as the buzz of a vibrant city fills your ears. Next minute, the bridge's designer sidles up to you and informs you the bridge was not formed in a steel foundry and assembled by construction workers as you assumed. It was 3D printed, on-site, by robots. Now you look down at the brown, murky depths beneath you – and feel a little nervous. Because if you work with metals, the first thing you ask yourself is; how thoroughly has the material been tested?

We get excited about advancements in technology, and the whole idea of 3D printing is about as exciting as it gets. (That Dutch bridge is soon to be a reality, by the way.) And when traditional methods of forming intricate metal components involve taking material away, why wouldn't you favour a method that produces virtually no waste? That would allow you to create incredibly complex forms previously impossible using milling and drilling. And produce them fast and cost-effectively.

But let's not forget, just like in a traditional metal manufacturing process, what comes out of a 3D printer is only as good as the raw material that goes in.

Companies are already selling 3D printing (or additive manufacturing as it's also known) in metal. The method of creating three-dimensional parts from a digital file often involves the building up of thin layers of material. This technology is already able to produce exceptionally complex shapes – some of which would be impossible to create using traditional methods like machining, forging or casting. Added benefits not only include the fact that you are minimising the use of materials, but you would also see a huge reduction in your tooling costs.

And there are many processes.

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Putting new methods to the test

Direct metal laser sintering (DMLS), for instance, is a particularly rapid technique that can produce strong, durable metal parts that can work equally well as functional prototypes or finished parts for use in production. Also known as Selective Laser Melting the technology works by evenly distributing thin layers of atomised fine metal powder using a coating mechanism onto a substrate plate. This happens inside a chamber containing a controlled atmosphere of argon, or nitrogen at oxygen levels below 500 parts per million. Once each layer has been distributed, each '2D slice' is fused by selectively melting the powder. This is where the laser comes in. Its energy is intense enough to 'weld' the particles together into a solid metal form. The process is then repeated layer by layer until the finished part is complete.

Materials used include aluminium, cobalt, chrome, copper, stainless steel, titanium and tungsten. But for any of these to be used as raw materials, they must first exist as pure elements or alloy powder. This 'powder' could be tested with an XRF (X-ray Fluorescence) metals analyser to ensure it's of the quality you need before turning it into a vital component.

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Yet, no sooner has a technique like DMLS become accepted, then another method comes along.
A 3D metal printing system hailed as faster, safer and cheaper than existing systems (which many already consider as fast, safe and cost-effective) is on the way. At a tenth of the cost of existing technology it's going to be irresistible to many manufacturers.

In this process the metals arrive in rod form, bound to a polymer binding agent and packaged in cartridges just like any other printer consumable. The printer prints parts into layers of bound metal before they go into a de-binding bath that removes most of the binding polymer, prior to the parts entering a sintering furnace. This uses a combination of heating elements and microwaves to bring the part up to a temperature just short of its melting point. Now the rest of the binding agent burns away and metal particles fuse with each other to produce a dense, sintered metal. The technique is being talked about, first, as simply a prototyping method. But its designers already have plans to use it to manufacture parts for real production.

Of course, the parts produced could be analysed quite easily using OES (Optical Emission Spectroscopy) technology. But as the future of these new manufacturing methods progress, metals analysis technology will need to be working alongside it – to ensure that while there's little to stop you making anything you want, there's also nothing preventing you from analysing it with speed, precision and accuracy, either.

Take that canal bridge in Amsterdam, for instance. We already make metal analysers that are so light and portable, you'd have no problem analysing the metal structure before you set foot on it.

2. Metals analysis and big data

Today, the speed, simplicity and convenience of a metals analyser means a member of staff could take thousands of readings in a working day. Without even pausing to recharge batteries in their handheld or mobile device.

In fact, all they'd need to stop for would be a couple of hard-earned coffee breaks and a sandwich for lunch. In other words, in just one working day one person can gather a colossal amount of complex data. Of course, once gathered, all the results and reporting will need storing somwhere.

In contrast, imagine the scene just a few years ago when a certain supersonic jet recorded its one and only catastrophe. The component suspected as the culprit fell from the plane that took off before it. The component left on the runway punctured the jet's tyre, and the tyre caused an engine fire. The blame was passed around from airport to airline to aircraft maker until the company that made the component were forced to trawl desperately through their own data, trying to verify when the part was made and that it met the correct specifications. Imagine the man hours (and mayhem) involved. Today, with the ability to collect and store huge amounts of data – and more importantly, retrieve it in an instant – it could be easier to resolve issues like this, saving time, money and heartache for all.

In the twenty-first century, information is king. One reason it rules in the metals industry is through its ability to make manufacturing quality assurance and control processes simpler and faster. It's why we have designed software specifically for a user to be able send, store and retrieve analysis results quickly and easily in a cloud-based service.

Today, it no longer matters whether you're at your regular place of work or out in the field – you can now access your data any time of the day or night. And there are a number of ways in which you can do it. As long as you have available WIFI, it's now simple to transfer results from your analyser to the cloud in real time. With our handheld XRF device, you can also connect via an iPhone or Android app. In fact, with our LIBS (Laser Induced Breakdown Spectroscopy) handheld analyser, you don't even need an app even though it's available on both iPhone and Andriod, you can connect to the cloud-based service directly whenever a WIFI network is available. And when you do, you can store chemistry, grade ID, camera images, spectra and other information all in one, secure location.

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Data in the cloud... and the device

The Internet of Things (IoT) is improving efficiency in other ways, too – through the ability of the equipment itself to make life more efficient. This network of physical devices, appliances – even vehicles – able to connect and exchange data has been growing apace. The number of online capable devices was estimated at 8.4 billion in 2017. Experts estimate that by 2020 the IoT will consist of around 30 billion objects. It's no surprise then, that the metals industry is taking advantage of the phenomenon for its users. At Hitachi High-Tech we are already putting the technology in place. Remote reporting and instrument diagnostics should eventually make instrument downtime (and so, in turn, production downtime) a thing of the past.

Yet data critical to your work needn't involve information sent from the device to its manufacturer or to a cloud-based server. Huge amounts of valuable data can be installed inside the device itself. If you're missing grades, today you can find them in a few simple steps.

GRADE Database is the largest metals database available. Pre-installed on our own optical emission spectrometers and optional for one of our handheld XRF instruments, the pre-installed metals database allows for very quick and easy grade identification. More than 12 million records for almost 340,000 materials from 70 countries are included.

For the user, this means no more time-consuming research in norms and grade catalogues. In just a few steps you can search for metals, worldwide, by specific chemical composition or mechanical properties. You can find equivalents to foreign metals and compare alternatives side by side – or cross reference. You can decipher metal specifications and find the correct grade for a specific application. Plus, you can more easily follow the ever-increasing pace of changes to national and international standards, such as AISI/ASDM, DIN, EN, BS, JIS and GOST. And the database goes beyond identification. It finds precise traceable and reliable mechanical, physical data for various conditions and temperatures. Even a list of suppliers. Today, when time saving is such a huge part of cost saving, the value and benefit of so much data is immeasurable.

The way forward for those working with metals can be summed up in a few words; costs, compliance and complex chemistry.

For that reason, information, whether it's pre-installed, sent via the Internet of Things, or in the form of big data could make life simpler, safer and more cost-effective.

8.4bn

online capable devices

3. The reduction in quality as competition increases

Nostalgia can be deceptive. Things always seem to have been better “back in the day”. But when it comes to manufacturing with metals, forget soft-focused memories – let’s talk hard facts. The truth is, many basic materials were of a superior quality in the 1970s. Steel, for instance, had a much higher nickel content for one thing. But as the decades have progressed, production techniques and competition have driven down the price of steel in real terms. And it seems the quality has followed.

One contributing factor is that for certain countries there are huge tax advantages to adding low-cost elements to materials such as steel. The government of one of the world’s biggest alloyed steel exporters supports it with a tax reduction of between three and nine percent.

As most in the industry know, one of the cheapest ways to make alloyed steel is to add low-cost boron. When exported, this is often declared as ‘unalloyed structural steel’. However, the quality and quantity of boron is critical. Boron is added for its unique ability to increase ‘hardenability’, but too much or too poor a quality can lead to fatal catastrophes. Primarily, because it reduces the weldability of steel and can cause cracks in the welding seams. Consider that information, and the amount of steel that goes into the construction of an off-shore oil-drilling platform for instance, and the potential for both human and environmental catastrophe is obvious. And the need for precise, accurate analysis of materials paramount.

Lower taxes, higher risks

With imported materials in huge demand, and different countries with different attitudes to quality competing with each other, the hope is that the exporters' need for cost-cutting will be accompanied by tighter controls by the importers. It's no surprise that customs and excise staff are arming themselves with materials analysis technology.

What's more, as lighter alloys become increasingly advanced and innovative in their make-up, it looks like the industry is heading for an environment where analysers will need to be able to detect lots of different elements in much lower concentrations within a single sample of material – to ensure quality is maintained. Add to that the fact that technology firms are developing products that are made up of many different types of alloy and metals within a single product, and the future will see manufacturers needing to invest in a complete range of analysis technology, from XRF to LIBS to OES. Furthermore, every single item of that equipment will need to be precise and reliable.

If metals play a big part in your production process, accurate analysis is going to become more and more important for your future success, for your reputation, and for your bottom line. Perhaps the next time we look at the past with rose-tinted glasses, we should check the metal spectacle frames are up to the job.

4. The rise of the robots
(and the fall of the dull analysing task)

In manufacturing, it's well known that the biggest transformation since the industrial revolution has been quietly taking place in factories and manufacturing plants around the globe. We are talking, of course, about the rise of robotics and artificial intelligence (AI).

Because, according to a PwC survey, even back in 2014, 59% of manufacturers were already using robotics technology in one form or another.

Thanks to robotics, the factory floor and laboratories of the future will be more efficient and more connected. They will allow for more real-time monitoring of the production process and the automation of sample analysis – and not necessarily from the factory floor itself. For example, in steel mills, when samples are taken during multiple parts of the metal production process to ensure that each melt meets strict quality control criteria. Here, 'robots' ensure that feedback from the laboratory back to the operatives happens in minutes, making sure production continues to schedule, whether it's ready to be moved along or whether adjustments (to the sulfur level, for example) need to be made.

Robots can be programmed to operate 24/7 in lights-out situations for totally uninterrupted production. In a world where 'green' manufacturing is being constantly talked about (and growing) robots may need power, but they will ultimately save it. Robots don't need heating. They don't need lighting. And largely, they keep their working areas very clean, so no need for cleaners to take away waste bins or use 'toxic' cleaning materials.

The assumption is, that robots in the production process are bad news for the working man and woman. However, many companies argue that robots actually free up manpower (and womanpower) allowing companies to maximise worker skills in other areas. So, while the robots are doing the dangerous stuff, and just as importantly, the mundane and repetitive tasks, we humans get to do the potentially more interesting jobs. Like engineering and programming. Maintenance and management.

In metals-related manufacturing, robots have been around for years. The automotive industry was a very early adopter (Fiat even ran a clever advertising campaign that exclaimed their cars were hand-built by robots). And now in metals analysis, automation and the taking away of the repetitive and mundane are available from Hitachi high-Tech. Whilst some of our most popular devices are handheld, we understand that humans will be less hands-on in the production processes of the future. That's why we already supply technology that can be built in to the production line.

For those workers responsible for the more repetitive aspects of metal analysis, this technology could make them feel a lot less like a robot themselves.

2014:

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5. Materials and their impact on the environment

Indium – a post-transition metal of vital importance to the manufacture of electrical components such as rectifiers, thermistors and photoconductors – was only discovered just over 150 years ago. And yet some reports suggest that in as little as five years, we'll run out of it.

It's just one example of why, in the years to come, manufacturers might not always look to traditional sources to supply them with raw materials. They may look inside the waste bin, instead.

1000KG
gold from recycled Apple products

Precious waste

Car manufacturers are a prime example. They have long been investigating in ways to make their products 100% recyclable. Some are mapping out every single metal used in a vehicle's construction. Firstly, so that recycling is easier, and secondly so that the better metals can be re-used more efficiently. Meanwhile, in the electronics industry, where high value metals are used in tiny components, manufacturers are looking at more ways to recover copper, silver and gold and many more precious metals. In one report, Apple revealed that it recovered nearly 1000kg of gold from recycled Apple products in 2015. That's over USD 42 million-worth at today's gold prices.

Of course, while experts agree there's no limit to the amount of times you can recycle exotic metals, the more times you do, the more additives start to accumulate. And that's why the need for analysis will be increasing in the years to come. To ensure a few tiny traces of unwanted additives don't become hazardous amounts.

Politicians are fond of telling us that they can't "wave a magic wand" and solve the world's environmental issues. But we can point a precision-made analyser at the metals we use and make the industry a world leader in responsible recycling for the future.

To conclude

3-D printing is here to stay, and the ability to ‘print’ in metals is moving far beyond prototype components to finished metal components that could potentially fail. In the future, we believe that the analysis of finished products will be straightforward. However, it’s the testing of the raw materials that could make analysers your most valuable tools.

Those other invaluable tools, data and information, can also now be an essential part of a complete metals analysis ‘toolkit’. Whether it’s through the device being connected to the cloud, through the IoT, or installed within the instrument itself, Hitachi High-Tech ensures that in future, everything you need to know will be immediately at hand.

As global competition increases, there’s no doubt that the quality of materials from some areas will decrease. All we can assure you of is that as a producer of analysers, there will be no drop in quality from us.

We’ll also be increasing our research into ways to help you with automation. While the robot analyser that walks and talks is some way off, contact us about the devices that can be integrated into your production process right now.

Finally, as the world tires of phrases like ‘green’ and ‘environmentally friendly’ our industry has never been more alert to these issues. And there doesn’t seem any chance of us slowing down soon. As metals analysis experts and for the industry as a whole, this is one area we can really lead the way.

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About Hitachi High-Tech Analytical Science:

Hitachi High-Tech Analytical Science is a new global company created in July 2017 within the Hitachi High Technologies Group. The company is headquartered in Oxford, UK, with research and development and assembly operations in Finland, Germany and China and sales and support operations in a number of countries around the world.

Our product range includes:

- Optical emission spectrometers (OES) used by industries around the world for fast and precise metals analysis. All important elements down to low detection limits and high precision can be determined, including carbon in steel and all technically relevant main and trace elements in nearly all metals.
- X-MET8000 handheld analysers, used by thousands of businesses to deliver simple, rapid and non-destructive analysis for alloy analysis, scrap metal sorting and metal grade screening using precision XRF technology.
- Vulcan handheld analysers, with LIBS laser technology, identify metal alloys in just one second, making it one of the fastest analysers in the world. This hugely benefits businesses processing high volumes of metal.

Articles used for research

3D metal printing is about to go mainstream

MX3D Bridge

Rare metals getting rarer

The history of metals - an infographic

Introduction to Electronics Recycling

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Science for
a better tomorrow