Mitsubishi Materials Craftsmanship Magazine

BM001E

YOUR GLOBAL CRAFTSMAN STUDIO

Made in Japan

A Challenge is in the Air

A closer presence with our customers

"We wish to invite everyone to the exciting world of Mitsubishi Materials." It is with this thought that we launched this information magazine.
Adhering to our corporate philosophy to contribute to "people, society and the Earth," we are committed to helping our customers achieve smooth operations, increase their productivity and create new processing technologies. This is our mission as a tool manufacturer. To fulfill this distinct mission, we realize our role is to provide the best solutions and services in response to the needs of each of our customers, not simply as a tool manufacturer but as a "comprehensive craftsman studio" that our customers can feel close to. We hope to make Your Global Craftsman Studio an information magazine that will bring you closer to us. Its pages are filled with exciting news, the latest happenings of the present, unique technologies that are a fusion of many years of experience, the thoughts that our developers pour into new products and interesting information from around the world. It is not simply a product information pamphlet, but an embodiment of our spirit, brimming with themes and communication resources that delivers interest for everyone.
Generally, the main objective of publications is to unilaterally convey the thoughts of the publisher. In this sense, this magazine is like all publications, in that it is published with the hopes that each paragraph, each line could be of direct use for your activities. However, it goes without saying that excitement comes in many forms and in a wide variety and differs from customer to customer. Therefore, even if the content of this magazine does not directly relate to you now, we would be most happy if you would note the types of initiatives we engage in, so that when some form of challenge arises, it crosses your mind to inquire how we can help.
We at Mitsubishi Materials stand ready to respond to your needs with our comprehensive strength and full-heartedly provide the best solutions and services. This magazine has just begun, so please look forward to the exciting and interesting content that we will provide in this and future editions.

Fumio Tsurumaki
President
Advanced Materials & Tools Company
Mitsubishi Materials Corporation

YOUR GLOBAL CRAFTSMAN STUDIO

Vol. 1 Stories

Your Global Craftsman Studio

EYE on the MARKET AEROSPACE INDUSTRY

Special Feature

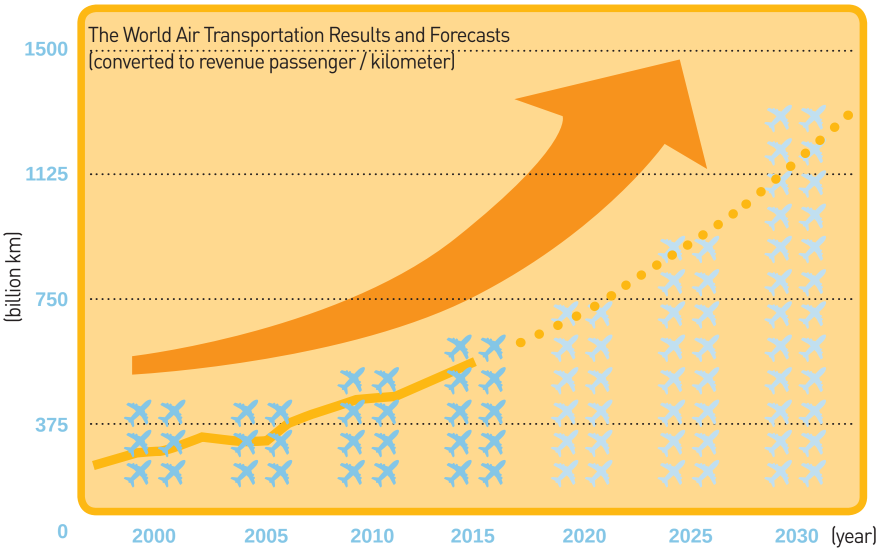
In the Air

Aviation Industry and Difficult-to-cut Material Machining

The Skies are Teeming with Activity

The Internet has made it possible for information to be transmitted throughout the world in real time. When it comes to moving people and products however, it's the aircraft industry that has taken the lead in reducing time. Since 1995, air transportation has continued growing at an annual rate of 5% (converted to revenue passenger-kilometers) despite two global economic recessions. It is predicted that Asia will lead the industry's growth over the next 15 years, whilst in Europe the wide variety of commercial airlines servicing almost every airport means that the skies will continue to become ever busier.

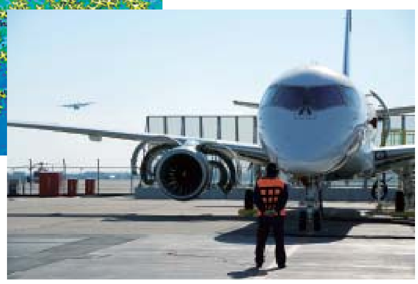
Air transportation will double in the next 15 years!



Source: The Japan Aircraft Development Corporation
“2014-2033 Commercial Airplane Market Forecast

The skies over Europe are filled with aircraft

Commercial aircraft operations in Europe
(10:00AM GMT)
http://www.flightradar24.com/



New Environmentally Friendly Passenger Jet

A huge variety of aircraft have been developed to meet transport market needs for service between continents, regions and cities; and now, the aircraft industry is revolutionising its products to address global warming and other environmental issues. In addition to increased ratios of light but strong materials, from titanium alloys through to carbon fiber reinforced plastic (CFRP) to reduce weight and lower fuel consumption, the Boeing 787, Airbus A350 and other new passenger jets have adopted new low-noise jet engines to realise significant reductions of environmental load. As for Japan, Mitsubishi Aircraft Corporation's new MRJ passenger jet is gearing up to begin commercial service. Airlines throughout the world are now adding jets to their fleets that are friendly to both passengers and the environment.

Photo provided by Mitsubishi Aircraft Corporation

Special Feature **In the Air**

EYE on the MARKET AEROSPACE INDUSTRY

Passenger Jet Components and Machining

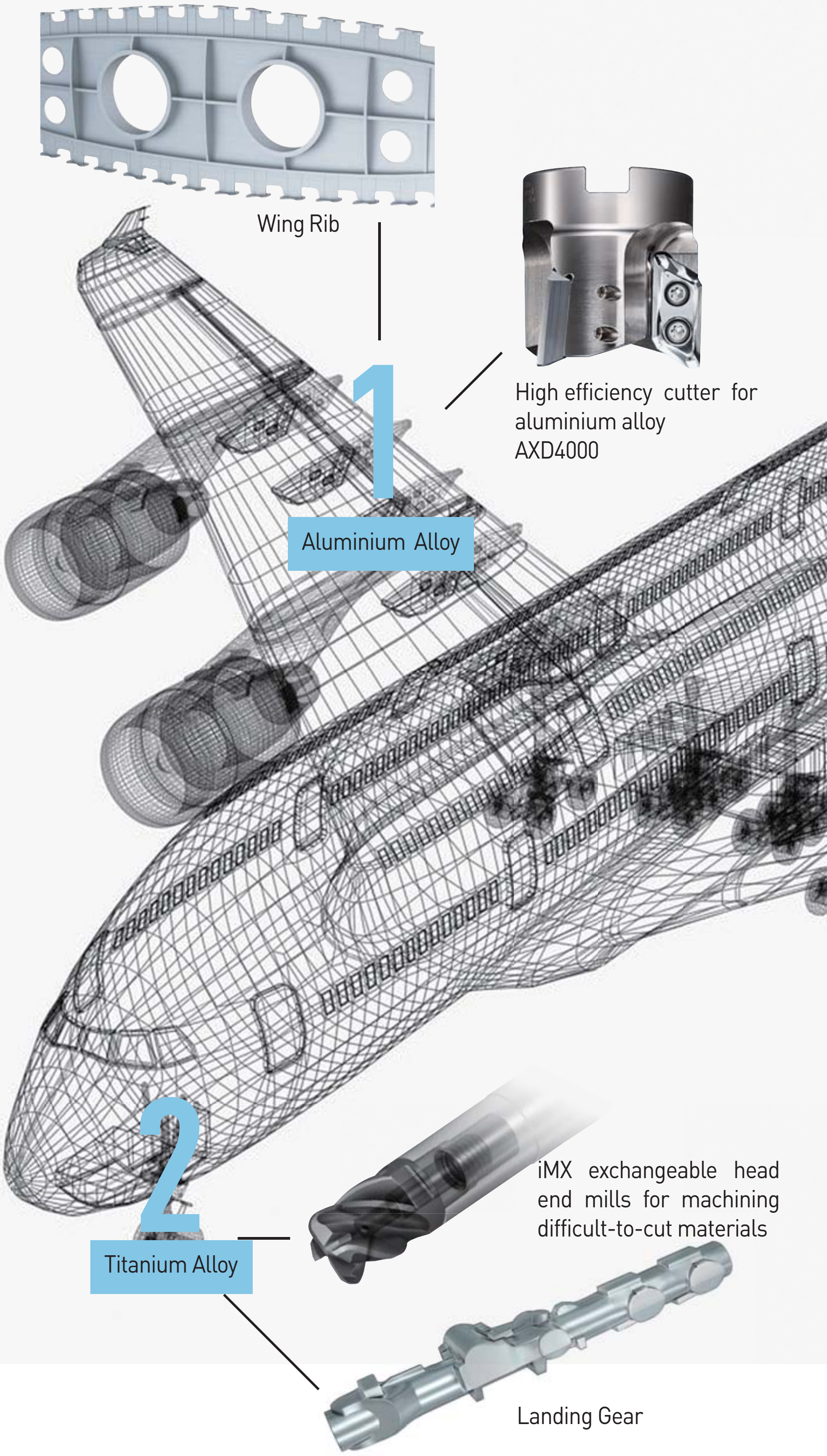
Most passenger jets have between 3 and 6 million components and light, strong materials are commonly used for these components. The majority of the structural components are machined and the engines use special alloys that can withstand extreme temperatures and pressures. The need for efficiency, precision and quality makes it essential to have cutting tools specifically designed for each material.

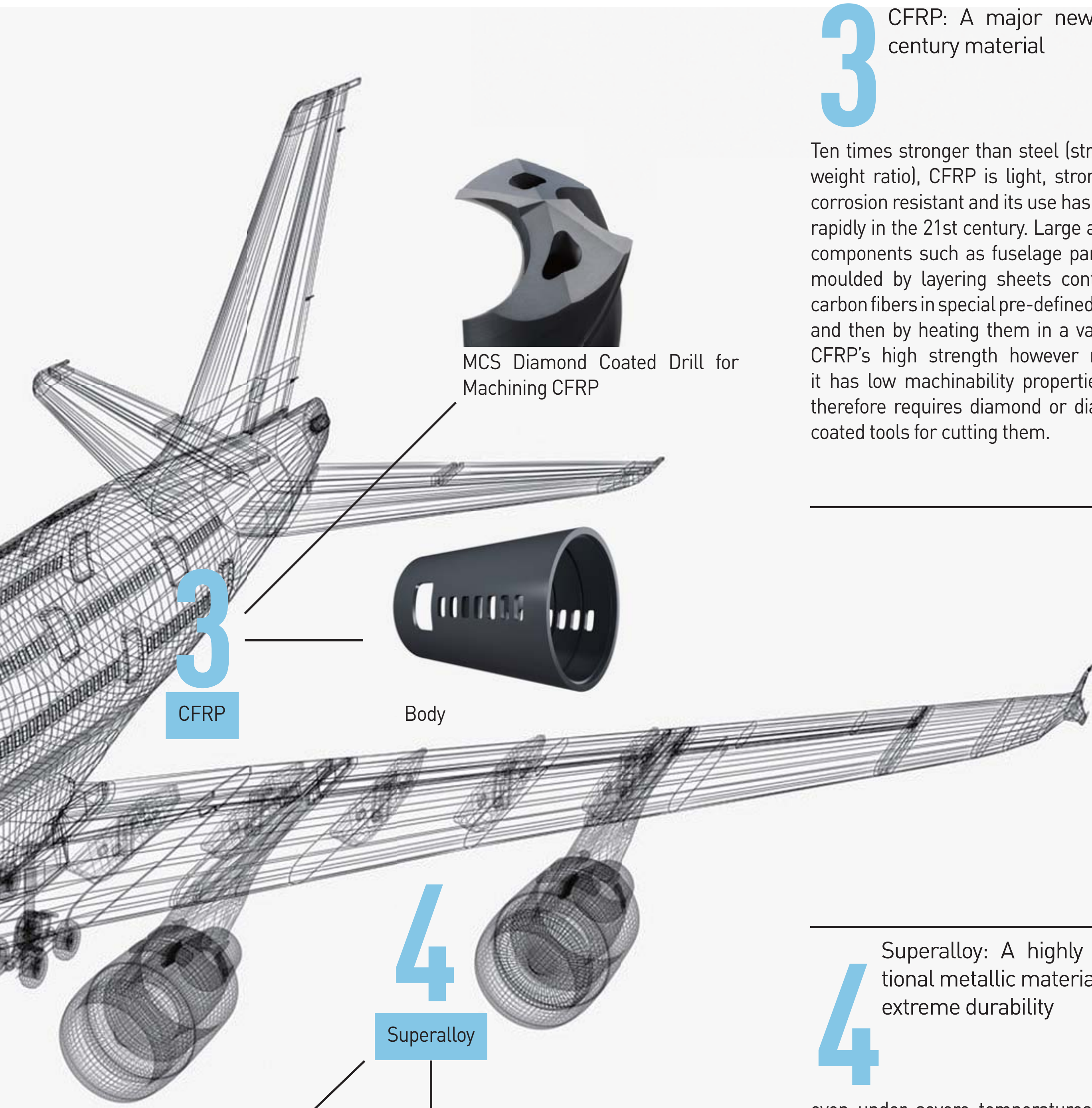
1 Aluminium Alloy: High-efficiency machining at ultrahigh speeds of 300km/h

Many of the panels and ribs (structure) of the airframe are made of super duralumin (A7075). High-efficiency processes are essential to machine components from blocks of material. These machining processes can sometimes reduce more than 90% of the solid material into chips to leave the final shape required.
Recently, cutting tools capable of machining components at a speed of 5,000m/min (300km/h) have been commercialised. The chip evacuation rate of these processes can be up to 10,000cm^3 per minute.

2 Titanium Alloy: Increases in the ratio of use have created more demand for highly efficient processing.

Titanium alloy has the highest specific strength (strength/weight ratio) of all metallic materials under 400 deg.C, it is also light, strong and corrosion resistant. New passenger jets are using an increasing ratio of Titanium alloy Ti-6Al-4V, this material is used for aircraft components that require high strength, such as wing joints and landing gear. High efficiency machining of Titanium alloy is a challenge because its low thermal conductivity causes machining heat to concentrate on the edge of the cutting tool.





MCS Diamond Coated Drill for Machining CFRP

Body

PVD Coated ISO Insert for Difficult-to-cut Materials MP9015/ MS Breaker

Disk

3 CFRP: A major new 21st century material

Ten times stronger than steel (strength/ weight ratio), CFRP is light, strong and corrosion resistant and its use has grown rapidly in the 21st century. Large aircraft components such as fuselage parts are moulded by layering sheets containing carbon fibers in special pre-defined forms and then by heating them in a vacuum. CFRP's high strength however means it has low machinability properties and therefore requires diamond or diamond coated tools for cutting them.

4 Superalloy: A highly functional metallic material with extreme durability

even under severe temperatures of up to 1,000 deg.C. It is used in sections of the engine associated with combustion and exhaust. Nickel based INCONEL® and WASPALOY® are common examples. Superalloys maintain their strength even under high temperatures but these properties also cause low machinability. They also require high quality machining and therefore manufacturing processes need careful examination and planning before mass production is viable.

INCONEL® is a registered trademark of Huntington Alloys Canada, Ltd.
WASPALOY® is a registered trademark of United Technologies, Inc.

EYE on the MARKET AEROSPACE INDUSTRY

From Japan to the World. A Passion for the Aircraft Business

Mitsubishi Materials Corporation began full scale development of cutting tools for the aircraft industry in 2001. However, the high standard of tools already available in Europe and the US meant a continual development process of aerospace tools to where Mitsubishi Materials Corporation now provides a diverse line of high performance cutters. In addition the Company has a total of 20 aerospace experts stationed in 10 global locations, including Japan, the US, Asia and Europe. With a priority on improving the technology of its products and machining processes, a level has now been reached that allows the Company to participate in joint international development projects for new passenger jets. Two experienced managers from Mitsubishi Materials Corporation are taking part to help contribute Japanese know-how to the advancement of the aircraft business.

Competing with Comprehensive Power

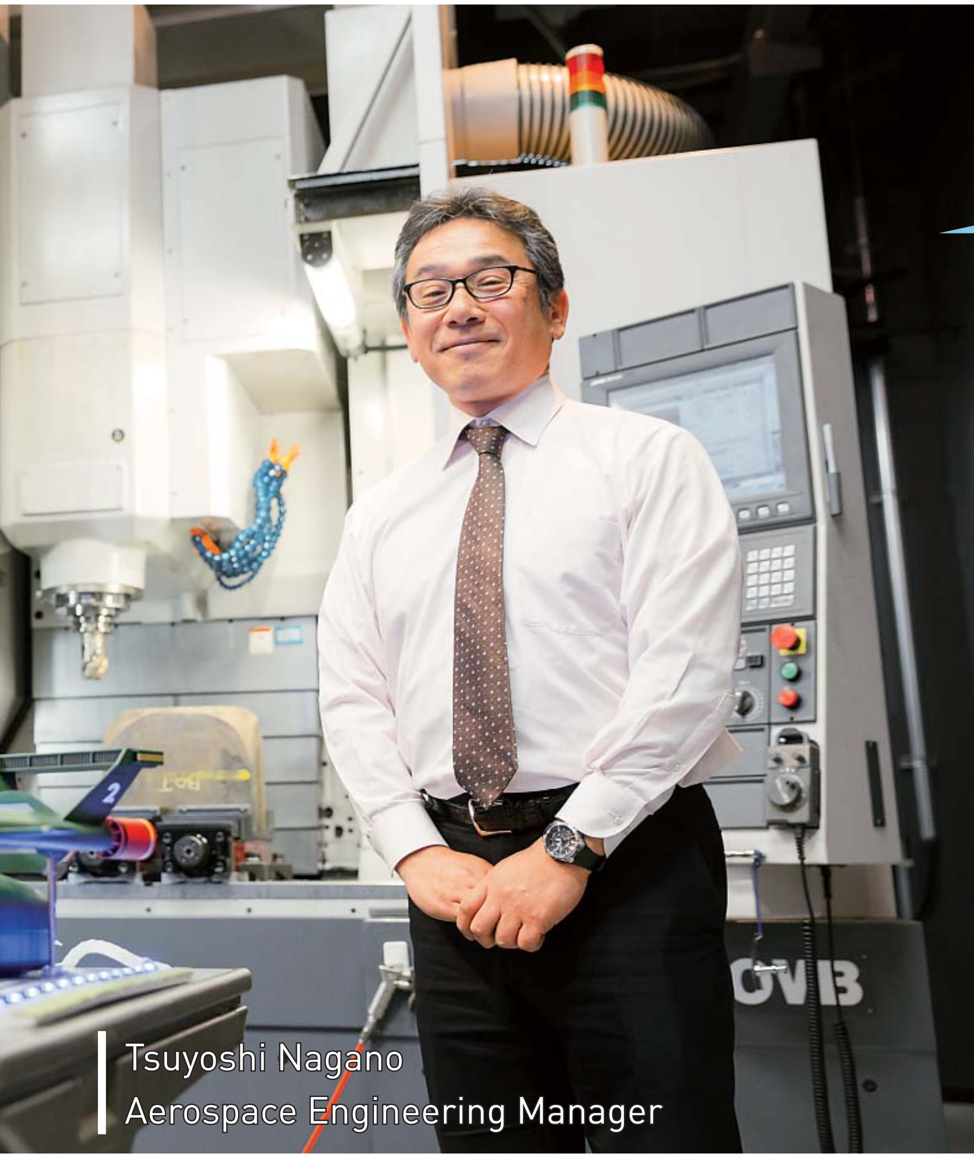
Aerospace Business Manager Masaaki Ito approaches machining from a comprehensive perspective, using his 11 years experience at a machining tool manufacturer working with ISO compliant tooling systems for combined machining equipment. The technology developed by his department has been developed by machine tool manufacturers in collaboration with universities and research institutes as well as aircraft manufacturers. Masaaki Ito says, "Our high-efficiency processing technology for difficult-to-cut materials has reached a level that could not be achieved by a machine tool manufacturer alone." Mitsubishi Materials Corporation has strategically promoted the establishment of world partnerships for further expansion of the aircraft business. In line with this, the Company joined the world-class Advanced Manufacturing Research Centre (AMRC) in the UK in spring 2014. AMRC carries out research on projects from major aircraft manufacturers and has utilised Mitsubishi's solid end mills for titanium alloy machining. Currently, the Company is working in close cooperation with specialists placed in domestic and global R & D sections and is combining these efforts into the design of new products that will advance the next generation of machining.

Masaaki Ito
Aerospace Business Manager


A partnership contract was submitted to Adrian Allen, Commercial Director, Advanced Manufacturing Research Centre (AMRC).


JIMTOF 2014 (The 27th Japan International Machine Tool Fair)
Aircraft exhibition on the Mitsubishi Materials booth


Mitsubishi Materials booth at the Zhuhai Air Show (China)
Explained to the Chinese media


Tsuyoshi Nagano
Aerospace Engineering Manager

Expert in Machining Difficult-to-cut Materials

Engineering Manager Tsuyoshi Nagano has been involved in the development of machining technology since he joined the Company some 20 years ago. He has managed in-house development testing and new processing technology development which have led to his achievements being featured at exhibitions throughout the world. After transferring to application engineering his wealth of experience in machining technology helped him establish trusted relationships with aircraft and machine tool manufacturers. He has worked mostly in Asia and Japan with a focus on practical technology support and problem solving for difficult-to-cut materials utilising the Mitsubishi Materials network. He also promotes participation in machining and aerospace exhibitions in North America, Europe, and China as well as in Japan. Mitsubishi Materials was the only cutting tool manufacturer from Japan to participate in the 2014 Zhuhai international aerospace show, the largest in China.

FOCUS on PERFORMANCE AMRC

Mitsubishi Materials Creates 'Step Change' for Aerospace Industry

The global aerospace industry is an ever more important sector for manufacturing and is dominated by the USA and Europe. At the very cutting edge of this industry sector is the Advanced Manufacturing Research Centre (AMRC) with Boeing, a cluster of world class centres for research into advanced manufacturing technologies used in the aerospace industry. For this first issue of the Mitsubishi Materials in-house magazine, our editorial team visited the AMRC to understand how the relationship between Mitsubishi Materials and the AMRC benefits the aerospace sector.

What is the AMRC?

The AMRC in Rotherham near Sheffield, UK, was initially founded in 2001 as a collaboration between the University of Sheffield and Boeing with support from Yorkshire Forward and the European Regional Development Fund. The AMRC cluster has specialist expertise in machining, casting, welding, additive manufacturing, composites and training. It now has over 80 industrial partners that include Boeing, Rolls Royce, BAE Systems, Airbus and of course Mitsubishi Materials. The centre acts as a support mechanism for the aerospace industry, driving technology brands such as Mitsubishi, DMG Mori, Nikken, NCMT, Renishaw, Starrag and many others to develop innovations that enable the aerospace OEMs to hit their targets. Targets that will primarily be to manufacture components and assemblies faster and more efficiently without increasing the shop floor plant list.

To put this philosophy into perspective, by 2032 it is estimated the global industry will demand 29,000 new large civil airliners, 24,000 business jets and 5,800 regional aircraft valued at over US$5 trillion. As a result innovation centres such as the AMRC is driving innovation together with industry to ensure the global airline industry is able to meet these demands.

During our visit to the AMRC, we spoke with AMRC Commercial Director and Co-Founder, Mr Adrian Allen OBE who highlighted the initial ambition behind founding the technology centre over ten years ago. As Mr Allen told us: "When Professor Keith Ridgway CBE and I founded the AMRC, one of our key ambitions was to create sustainable wealth for everybody involved. We didn't define wealth purely in monetary terms but in terms of creating highly skilled jobs, value and profit for our partners.

"In the early days we set tangible targets against a timeline, but, after we built our first centre in 2004, we rapidly exceeded our targets and doubled in size within four years. In 2014 we opened our training centre and that has rapidly grown from a first intake of 160 apprentices to the current level of more than 400. One of our initial aims was to generate highly skilled engineering jobs and with this centre, we are realising our ambitions and creating the next generation of UK engineers."

The AMRC now has seven buildings with the latest expansion being the ‚Factory 2050' project. Earmarked to be opened later in 2015, it will be the first fully reconfigurable digital factory in the UK and will take the overall floor area of the AMRC to 38925sq/m.

Adrian Allen OBE
AMRC Commercial Director and Co-Founder

Tom Jones
General Manager, MMC Hardmetal U.K. Ltd.

What Happens On The AMRC Shop-Floor?

The shop floor at the AMRC is regarded as the industry test bed for the next generation of production technology. The machine tools at the AMRC are provided by either the machine tool manufacturers or the aerospace OEMs. New technological developments for cutting fluids, cutting tools, workholding and toolholding, CAM software and machining strategies as well as new material compositions are all tested to the limit on the machines.

To ensure smooth up-scaling from research to full production, the AMRC uses industry standard machine platforms.

The benefit for the aircraft OEMs is that existing machine tools are optimised by introducing new techniques and strategies without disrupting existing production. For the equipment suppliers, their technology is rigorously tested under conditions that are dictated by the leading names in the aerospace industry. The comprehensive testing of the Mitsubishi Coolstar end mill range is one example.

In 2013 Mitsubishi Materials approached the AMRC regarding membership and shortly after a Tier 2 membership was agreed. Mitsubishi Materials supplies its latest cutting tool innovations and provides technical support to the AMRC engineers. In turn, Mitsubishi is given full results and feedback from the cutting tool trials. Recommendations based on the trials at the AMRC are also part of the process.

What Does Mitsubishi Materials Bring to the AMRC?

Highlighting the importance of Mitsubishi's contribution at the AMRC, Mr Adrian Allen OBE continues: „We are proud and honoured to be working with Mitsubishi Materials. Japanese manufacturers have changed the industrial landscape and the AMRC wouldn't be the facility it is today without our Japanese associations."

"As a commercial entity, we want to be associated with the biggest brands in manufacturing, as that raises our profile and drives the technology enhancements for industry. Mitsubishi is a name that is very well known and highly regarded in Europe. It's a name that brings kudos to the AMRC and helps to build the AMRC brand. We strive for recognition, which leads to respect and eventually earns rewards for all our partners. Behind this, we take a holistic view of the industry and we want the leading global companies involved, so we can utilise the best technologies, products and expertise available. Mitsubishi Materials is one of the key drivers in the progression of cutting tool technology and we would welcome closer collaboration."

What Are The Benefits for Mitsubishi Materials?

With the AMRC providing a unique platform for trialling the latest developments under industry test conditions that are dictated by global aerospace OEMs, the lead engineers at the AMRC deliver results that encompass the complete OEM configuration. These unique test conditions factor in the machine tool, material type and tool path strategies that are often beyond the realms of cutting tool manufacturers' in-house testing facilities.

For example, the 5-axis Starrag STC1250 at the AMRC is the industry standard for this type of machining and has dynamic capabilities for testing the Coolstar end mill to its maximum.

FOCUS on PERFORMANCE

The Trials

The AMRC has a number of internal research divisions that include the Process Technology Group - covering Structures and Landing Gear, Casings, Shafts and Disks and Blades – and a Composites Centre. At the time of joining the AMRC, Mitsubishi began working with the Structures group on a titanium pocketing project. As the lead engineer involved with the AMRC, Mitsubishi UK's Advanced Materials Application Manager, Mr Adrian Barnacle, says: "The AMRC tends to focus upon projects that OEM partners have planned for the future. With aero structural titanium parts, OEMs and the industry in general has focused upon using heavy duty ripper cutters at full machining depth and width parameters with slow feed rates. However, MMC has identified that by machining with smaller cuts at significantly higher speeds/ feeds; in combination with new tool path strategies, cycle times and costs can be significantly reduced. In essence, Mitsubishi Materials is changing this industry perception."

Compiling the data at the AMRC, Mr Daniel Smith trialled Mitsubishi's variable helix multi-flute Coolstar range which was developed around the recent innovations in through flute coolant delivery and increased blank size geometries. Immediate feedback from the AMRC was that the 20mm maximum diameter of the Coolstar was below the industry norm of 25mm, so Mitsubishi developed a 25mm Coolstar for trial purposes.

The AMRC initially trialled a variable helix multi-flute VF6MHVCH Coolstar end mill and set a flank wear of 0.3 as the limit, but this value was never reached. Instead, the selected tool failed due to chipping at the chamfer edge. At this point, it was predicted that with a 3mm corner radius applied it could run for much longer periods and the increased radius would reduce the chances of brittle fracture. It was also apparent that a surface speed of 90m/min was far too low because the flank wear was measured at only 0.1mm after more than 30 minutes of cutting. It was felt that surface speeds of up to 200 m/min could be achievable, and still give acceptable tool life.

From these findings the decision was made to take the straight fluted Mitsubishi tool forward for specific customer funded work where a 3mm corner radius was used.

It was put forward that this type of tool could both rough and finish aero structure parts (pockets specifically) at cut depths of up to 80mm in high speed operations. If successful a potential metal removal rate of 133cm3/min could be achieved.

By optimising the effective radial depth of cut in a process the thermal and mechanical cycles imparted on the tool are controlled, allowing for the ideal parameters to be applied at all times. Observations made during trials showed that a speed of 130m/min and a chip thickness (Hex) of 0.08mm gave the most stable process for the setup used; these provided an estimated initial demo tool life of around 60 minutes at metal removal rates of 133cm3/min.

Daniel Smith | AMRC Structures Platform Group Engineer - Process Technology Group (right)
Adrian Barnacle | Advanced Materials Applications Manager, MMC Hardmetal U.K. Ltd. (left)

Adam Brown
Structures Platform Group Technical Lead - Process Technology Group

Mitsubishi Materials Creates a ‚Step Change‘ In Machining Philosophy

Mr Daniel Smith, the AMRC lead engineer on the project stated in his report: “The 25mm development tool has a proven ability to run at elevated surface speeds with little effect on tool life when radial engagement and other temperature generation factors are controlled. Furthermore, speeds of up to 130m/min have been successfully trialled for roughing at ae = 10% of the tool diameter whilst finishing speeds of 160m/min yield an excellent surface finish and could potentially be increased to further reduce cycle times.“

Mitsubishi believe the impact this machining strategy and the Coolstar range could have on titanium pocketing applications is considerable.

Adrian Barnacle states: “For pocket machining the Mitsubishi Coolstar is considerably outperforming other tools when using these machining parameters.“

AMRC’s Structures Group Technical Lead Mr Adam Brown said: “The support that Mitsubishi has given the AMRC in the short time they have been partners has been extremely useful in terms of tooling development focusing on the needs of the industries we support. We particularly appreciated the engagement with Mitsubishi R&D in producing custom and development tools for testing. In all cases this has led to extremely successful outcomes for both research and application projects.”

Adrian Barnacle added: “The aerospace industry has predominantly been the benchmark for heavy machining of difficult materials, however customers now want to reduce on-machine times and stock removal by obtaining components and structures as close to the near net shape as possible. With this mindset, the light and fast machining strategy for the Coolstar is already putting us at the forefront of the industry.“

The Results

In tangible terms, this project has benefitted both the AMRC and Mitsubishi Materials. Firstly, it has driven Mitsubishi to extend the Coolstar range with larger diameters and corner radii to meet the industry standards. Additionally, it has given Mitsubishi an insight into the very latest strategies and this information can be used to support the development of future products. The benefit to the AMRC is that it has a better understanding of the characteristics of Mitsubishi’s high performance carbides and geometries which opens the way to new collaboration on industrial projects. It also helps Mitsubishi and the AMRC when they are called upon to give advice on best practice strategies to OEMs.

Adrian Barnacle states, “the benefit to OEM partners as a result of the project will be reduced cycle times, improved surface finishes and reduced tooling costs.” All this rounds nicely back to Mr Allen‘s initial comment about the philosophy of the AMRC generating wealth for all parties involved.

What Does the Future Hold?

The next step is to look at additional AMRC projects, as Mr Adrian Barnacle concludes: “We have only scratched the surface with our potential at the AMRC. This project was with the aero structures division and we are now also turning our attention to the casing and engine division and the composite division. At present, we are very pleased with the Coolstar implementation, which is primarily for small pocket production in titanium. We are now looking at trialling our high feed indexable AJX line of face mill cutters for rough machining larger titanium pockets and also our iMX line of indexable end mills with a screw type head for finish machining of pockets.“

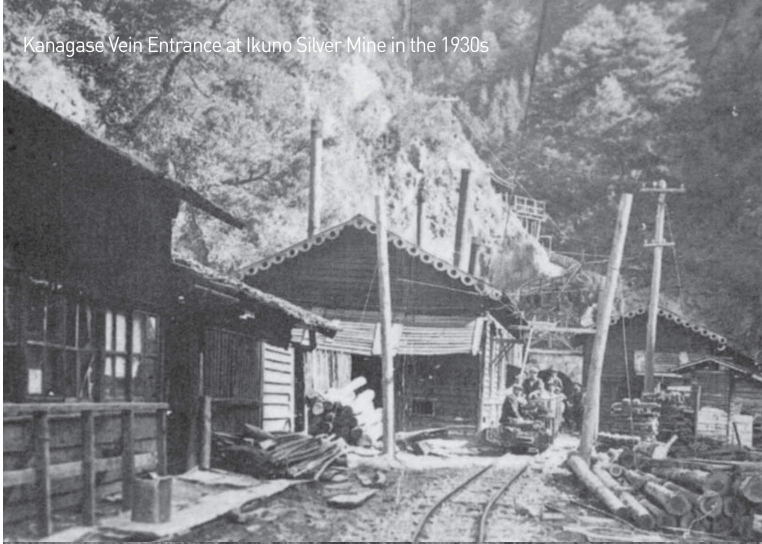
HISTORY OF MITSUBISHI

Vol. 1

Supporting the modernisation of Japan through the production of silver

Ikuno Silver Mine

The history of Mitsubishi Materials Corporation began with the entry of Mitsubishi Group predecessor Tsukumo Shokai into the mining industry. After the establishment of its marine transportation business in 1870, Tsukumo Shokai progressed into the coal-mining business where it developed as one of the core businesses of the Mitsubishi Group. Among the many mines opened by the company, this feature focuses on Ikuno Silver Mine. This became the base of its processing business and silver production supported the modernisation of Japan. It is still operating today as the Ikuno Processing Center.


Kanagase Vein Entrance at Ikuno Silver Mine in the 1930s


Riding in carriages to enter and exit the vein (Ikuno Silver Mine in Showa Period)


Drilling with the Jumbo I Drill manufactured by Ikuno Factory (1955)


Hand sorting at a mill

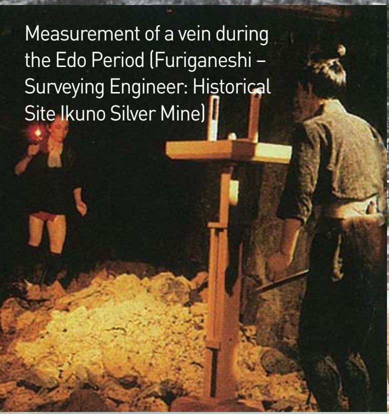
Ikuno Silver Mine's stellar production

An hour's ride on the Bantan Line from Sanyo Shinkansen Himeji Station brings you to Ikuno Station in Asago City, Hyogo. Another 10 minutes to the east through Kuchiganaya, Ikuno, brings you to the Historical Ikuno Silver Mine Site (operated by Silver Ikuno Co., Ltd.). The stone gate is adorned with the Imperial chrysanthemum, an emblem that shows the mine was once owned by the Royal Family. The site is equipped with an approximately 1,000m long tunnel organised for tourists utilising the remains of an actual tunnel and mine. There are also displays of a variety of valuable materials that show aspects of the silver mine over its 1200-year history. Ikuno Mine was thought to have originally opened in AD807. Around 700 years later in 1542, Suketoyo Yamana, the Shugo-lord of the Tajima Region, started mining the Kanagase Vein. During the Edo Period (1603 – 1868) mining was controlled by Nobunaga Oda and Hideyoshi Toyotomi, and Shogun Ieyasu Tokugawa established the Silver Mine Magistrate. Along with the Sado Gold Mine and Iwami Silver Mine, Ikuno Silver Mine became an important source of income for the Edo Government. Ikuno Silver Mine flourished under the 8th Shogun Yoshimune (1716 – 1745), when the production of silver reached approximately 562kg per month. The livelihoods of more than 20,000 people were in some way connected to the Ikuno Silver Mine.

Growing into one of the major silver mines in Japan under Mitsubishi

In 1868, Ikuno became the first mine operated by the Japanese government and during this time French mining engineer Jean Franciszue Coignet brought advanced European mining techniques to the operations. The mine

The overall view of Ikuno Silver Mine Headquarters in 1920s



Measurement of a vein during the Edo Period (Furiganeshi – Surveying Engineer: Historical Site Ikuno Silver Mine)

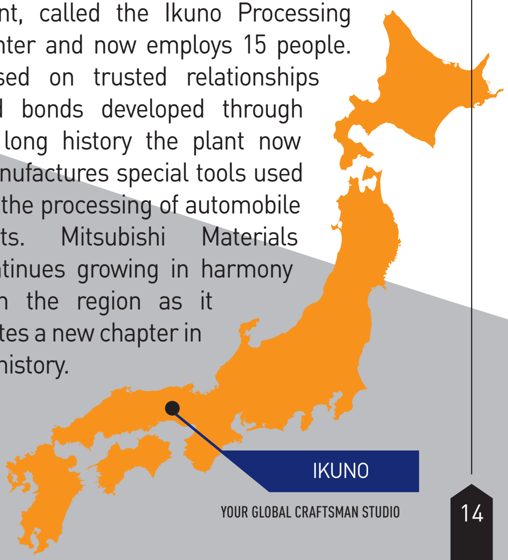
A new plant – Ikuno Processing Center (2015)

Ikuno Processing Center was established through the cooperation of young employees at Mitsubishi Materials Corporation

once became royal property but was later sold in 1896 to the Mitsubishi Joint-Stock Company, predecessor of the Mitsubishi Group. It grew into a major mine under the management of Mitsubishi and provided the basis for the Japanese monetary system. During the Edo and Meiji Periods its annual average production was approximately 3 tons, an amount which increased to 11 tons in the Showa Period. Ikuno Silver Mine's total production of silver over the 430 years since the start of full-scale mining until its closure was 1,723 tons. The number of miners employed to increase production during the war exceeded 2,600 and Ikuno town flourished along with its growth. However, the deterioration of quality and increasing mining costs led to the closure of Ikuno Silver Mine in 1973, ending its nearly 1,200-year history. The remains of the veins and mines have been preserved as a historical site and it now serves as a popular base for tourism in Tajima.

A new chapter in history begins with the opening of Ikuno Processing Center and continues to form firm bonds with people in the region

The population in Ikuno has been decreasing ever since the closure of the silver mine, but in August 2013 Mitsubishi Materials Corporation opened a new plant, called the Ikuno Processing Center and now employs 15 people. Based on trusted relationships and bonds developed through its long history the plant now manufactures special tools used for the processing of automobile parts. Mitsubishi Materials continues growing in harmony with the region as it writes a new chapter in its history.



Craftsman Story

Vol. 2

Kotaro Sakaguchi: Prototype Operator / Joined in 1998

Toshiya Matsumoto: Production Operator (former Prototype Operator) / Joined in 2004

Takayuki Azegami: Development Staff / Joined in 2006

Takahiro Misono: Production Technology Staff / Joined in 2006

Exchangeable Head End Mills iMX

Innovative Fastening Mechanism Produced by Craftsmen

The development of exchangeable head end mills started as far back as 2001. As with any long term development the end product turned out to be quite different from the first prototype. Mitsubishi Materials engineers considered the double face contact of the cemented carbide part of the system to be a critical aspect to satisfy the needs of maximum strength, rigidity and reliability; however, new technology was needed to achieve this. For this article, four engineers involved in the process were interviewed; two that specialise in development and production technology and two prototype machine operators.

Q: Please tell us about the background of the development.

Azegami: "There are two different end mill types: solid and exchangeable head types. End mills with exchangeable heads are very economical because they can be easily changed for different requirements which makes them suitable for a wide range of applications. Solid end mill bodies are as the description suggests, manufactured from one solid piece and this ensures high rigidity and precision. Therefore combining the merits of both types to better satisfy customer needs was the thinking behind the start of development in 2001. The original fastening mechanism supported the head through contact with the tapered surface alone, which didn't provide the strength and rigidity that was needed. In a process of repeated trial and error the conclusion was reached that using a double-face contact of the cemented carbide parts to the fastening mechanism would greatly improve performance. Frankly speaking this was very challenging and we were not sure at that time if it was possible to turn the idea into an actual product."

Misono: "We found that cemented carbide screw threads tended to break when tightened. This meant that we had to develop technology that would allow us to insert steel screws into cemented carbide."

Q: Is double-face contact with the cemented carbide parts really so difficult?

Azegami: "Yes. The double-face contact applied to the iMX series is formed by facilitating the elastic deformation properties in the tapered parts to create a strong contact between the end surface of the head and holder. While cemented carbide is super hard, it can also be brittle. What I mean by this is that cemented carbide used for cutters has an extremely small capacity for elastic deformation, so there is a high possibility that the holder will break when the head is tightened. To address this we used a tougher grade of cemented carbide, which is durable but not the same type commonly used for cutters."

Matsumoto: "When we made a prototype of the holder, the end surface of the holder was gradually ground in 1μm increments to find the perfect tolerance. After finishing the holder, we conducted a fastening experiment and confirmed that elastic deformation allowed the outer diameter of the holder to increase by just a few μm in the double-face contact state. We were very excited with the results."

Misono: "For the mass production of the double-face contact type fastening mechanism, we needed to develop a new technology that would allow us to set the strict dimensional tolerances needed, something that was thought to be impossible at that time for mass production. We looked at a wide range of fields, including inspection and measurement devices, machine tools and the overall process method before finally establishing the mass production technology we needed."

Sakaguchi: "When we first established the mass production system we had to respond to ever more difficult requests from the development section. The relationship between the manufacturing and development section was frayed for a while."

Everyone: (Laughs)

Q: Please tell us about the joint structure technology.

Misono: The iMX series uses a special joint structure from steel and cemented carbide that effectively utilises the characteristics of both materials. For manufacturers that produce cemented carbide and high-speed steel tools, it had been a long-term goal to establish technology that would allow a stable and strong joint between cemented carbide and steel. Technology for the joining of shanks and cutting heads made of different materials for the mass production of cutting tools was already being applied, but it was extremely challenging for us to adjust this existing technology. At the Akashi Plant, we started by looking at new machines and setting up an infrastructure we had little experience with. Smooth mass production also called for modification of existing hardware that required significant effort.

Azegami: "It was a process of trial and error. We were selecting different materials for the steel and cemented carbide parts and conducting repeated joint and tensile tests on hundreds of units before we were able to produce the strength that was required. It was a great feeling when the test operator finally signed off on product performance."

Sakaguchi: "It was important that after all the different phases of a long development process, something new and innovative was launched during JIMTOF 2012. We believe the final product reached that innovative target because we created a series of tools that would benefit our customers."

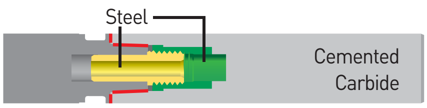
Q: Do you have anything you would like to say to our customers?

Azegami: "Since the iMX series was introduced to the market in 2012, customers that have changed from solid end mills have been very satisfied with the results. With the outstanding strength and convenience that comes with the exchangeable head technology, I am confident that more and more customers will be looking at implementing iMX series."

Misono: "We will continue working on the development of precision manufacturing technologies to meet customers' needs with high quality products. Our products feature the most advanced technology and I am sure that we'll be seeing expanded use of them in the market place as their popularity spreads."

Sakaguchi: "The iMX series development now focuses on responding to customers' needs, and I know the market is also looking forward to seeing our new products."

Matsumoto: "Due to our prompt response to customers' requests for special as well as standard products, the popularity of the iMX series is certain to grow."



Fastening Mechanism between Head and Holder

A finished product. (Left) An early prototype. (Right)

TECHNOLOGY ARCHIVE

Miracle Coating: Evolution of a technology ahead of its time

The road to new Miracle products

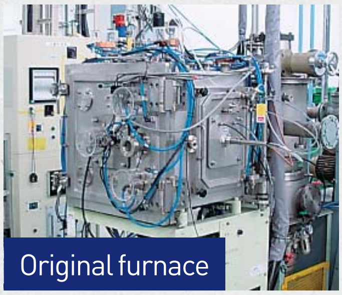
In the late 1980s when TiN coating was at the height of its popularity, aluminium-rich Al-TiN coating appeared and took the spotlight by completely changing existing conventions. The technology was named Miracle Coating and this article takes a look at the coating that changed the history of cemented carbide tools.

TECHNOLOGY ARCHIVE

Part 1 1987 ~

Miracle Coating was the result of a unified effort

Aluminium-rich TiN coating hit the market in 1987. This new coating was developed when the high speed steel tool manufacturer Kobe Steel Co., Ltd; at what would later become Mitsubishi Materials Corporation Akashi Plant, entered the carbide cutting tool business. The dark violet coating is popular now but the trend at that time was gold TiN coating. Of course, this was a technology to be proud of but it wasn't certain how the new coating would perform in the market place. Samples were exhibited at JIMTOF in 1988 and the cemented carbide Miracle coated drill was introduced in 1990. In 1991 the Miracle end mill was also introduced to the carbide tooling market. Although there was a degree of anxiety prior to launch, the Miracle end mill was highly praised as an outstanding product and unlike anything that had been seen before. As a result, the company moved to quadruple its production capacity. It was a great source of pride that machining of mould materials after the hardening phase was now possible with Miracle end mills, something that was unthinkable at the time. Although electric discharge processing was a popular post-hardening process, faster manufacturing by machining with end mills significantly reduced the lead time of moulds. The product became a Miracle tool. Ironically, because Miracle Coating was even more durable than the company could ever have imagined it left a shortage of materials for performance evaluations. It's still a big issue and often causes discussions between coating developers, who want evaluations in machining and evaluation staff, who want to reduce testing costs. Miracle end mills won the Technical Award of the Japan Society of Mechanical Engineers in 1995. In the same year, the Nozomi Shinkansen also received the same award. It is satisfying to know that the technologies applied to the end mill were viewed as being as valuable as the Shinkansen.



Original furnace

Miracle drill

Miracle drills exhibited at JIMTOF 1988

Miracle end mill

The world's first dark violet cemented carbide end mill

Part 2 1996 ~

Diversified Miracle Coating technology

Aluminium-rich TiN coating, which was the major feature of the original Miracle Coating, and the existing manufacturing know-how supported the application of Miracle Coating to a wider range of products. Mitsubishi Materials, for example, was the first company to add Si, which was widely used in PVD coating. AlTiSiN coating incorporated the high hardness and oxidation temperature characteristic of Miracle Coating, and in conjunction with newly developed cemented carbide materials and geometries, made it possible to machine steels with a hardness greater than 60HRC. Another class leading example is the Violet coating AlTiN that is applied to high-speed steel tools. Coated high-speed steel tools are actually more difficult to manufacture than cemented carbide types. Although high temperature is required to optimise the features of a coating, the hardness of high-speed steel tools deteriorates at 550 degrees C and above. This creates a need to maximise the features of both coating and tool by finding the best balance. All companies involved in coating need to overcome this difficulty and Mitsubishi Materials are always striving to advance the technology. Violet drills were difficult to develop but they are still popular and the hard work needed to finalise a successful tool for the market place was worth the effort.

Violet High-Precision Drill Series VA-PDS (with violet coating)

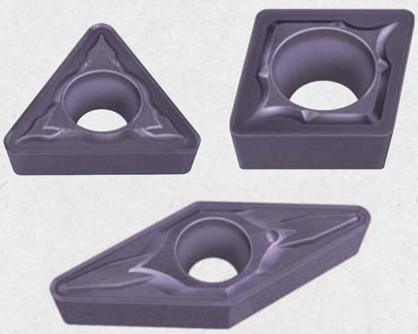
Miracle end mill VCMD enables the machining of steels with hardness greater than 60 HRC

Part 3 2000 ~

Inserts and cemented carbide drills become the major technology

In 2000 the Akashi Plant became a direct subsidiary of Mitsubishi Materials Corporation. Miracle Coating technology was immediately applied to solid carbide drills and also to carbide inserts, one of Mitsubishi Materials' major businesses. Insert processing at that time relied on CVD coating methods, with PVD coated types used only as a secondary line. However, with the development of Miracle Coating and then combined with advanced tool geometries, PVD became the major technology. The VP15TF grade in particular became a major material for inserts and delivered versatility through the synergy of Miracle Coating and a suitable substrate material. To emphasise the popularity of this new grade, it was often said, "If you don't know which grade to use, use VP15TF."

Miracle Coating was also applied to cemented carbide drills. Unfortunately, the Miracle drills produced at the Akashi Plant in 1990 were not as profitable as had been hoped. However, the ZET1 series of drills that were produced at the same time and the new WSTAR drills led to the expanded use of Miracle Coating for drilling applications. In terms of solid end mills, a new Impact Miracle Coating was developed that combined nano-crystal mono-layers of Al-Ti-Si-N. Combining this new coating with a suitable cemented carbide material led to the introduction of Impact Miracle end mills. The introduction of this new generation of Impact Miracle end mills meant HSS materials could be machined, where as previously HSS could only be machined by grinding or eroding.



Inserts (VP15TF) coated with Miracle Coating

Impact Miracle Coating combining integrated nano-crystal layers

Miracle ZET1 drills – Cemented carbide drills

HISTORY

History of Miracle Coating Development

1987 Al-Ti-N coatings are developed at the Mitsubishi Materials research laboratory.

1988 Samples are exhibited for the first time at the Japan International Machine Tool Fair (JIMTOF 1988).

1990 World's first mass production of Al-Ti-N coatings begins. Sales of Miracle drills start.

1991 Sales of Miracle end mills start.

1994 Sales of Violet end mills start.

1995 Miracle end mills win the Technical Award of the Japan Society of Mechanical Engineers.

1999 Patent awarded for Miracle Coating.

2000 Development of inserts with Miracle Coating starts.

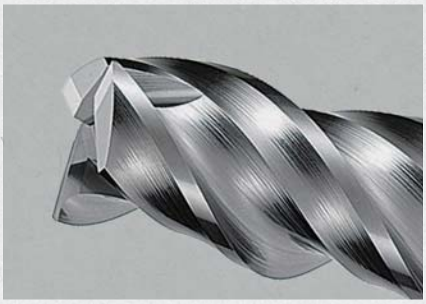
2001 Sales of Miracle Coated inserts start.

Part 4 2012 ~

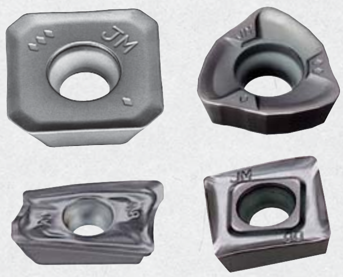
Evolving Miracle series

High performance products using PVD coatings have evolved through development that has focused on a wide range of applications. Combining technology and different coatings over a wide range of compositions, PVD coating has continued to improve at an ever increasing rate. Mitsubishi Materials' most advanced PVD coating series is "Miracle Σ." The Miracle Σ series Smart Miracle Coating was developed for machining of difficult-to-cut materials. This newly developed Al-Cr-N group coating delivers long tool life when machining Nickel based and Titanium alloys. With ZERO-μ Surface technology, adhesion of the material being machined was vastly reduced and lowered machining resistance to achieve surprisingly efficient results.

Inserts in six different grades were released through the MP61, MP71, and MP91 series for milling. These grades are individually optimised to meet the specific high performance needs for ISO P, M, and S material applications. The abrasion and thermal cracking problems that are often caused by milling are addressed with a nano-laminated Al-Ti-Cr-N group coating (TOUGH-Σ Technology). For turning inserts the MP90 series was introduced for machining difficult-to-cut materials and is based on an aluminium-rich Al-Ti-N compound, a special feature of Miracle Coating. For drills the multi-purpose DP1020 grade was developed and together with the nano-laminated Al-Ti-Cr-N group coating it was found this combination was successful in significantly reducing margin wear. Furthermore, with the unique ZERO-μ Surface and TRI-cooling through coolant hole technology, machining resistance was significantly reduced and improved chip removal performance realised stability when drilling.



End mills for difficult-to-cut materials



PVD coated cemented carbide inserts for milling

Inserts for difficult-to-cut materials

2002 Mass production of Miracle Coating overseas starts.

2005 Sales of Impact Miracle end mills start.

2012 Sales of Smart Miracle end mills start.

2013 Miracle Σ Technology is introduced. Sales of inserts made with TOUGH-Σ Technology start. Sales of MVE/MVS drills start.

Miracle Coating Progress

In the 28 years since Miracle Coating was first introduced, performance requirements for PVD coatings has become ever more demanding. Development and technology will continue moving forward so that products that exceed customers' expectations can be delivered.

Natsuki Ichimiya
R&D Department Coating Group

About Us

Machining Technology Center

Making full use of Mitsubishi Materials' experience and technology!

The Machining Technology Center was established in April 2010 in Saitama, Japan, as a base for the development and provision of solutions from Mitsubishi Materials.

"We collaborate with overseas technical centres to ensure the best in products and services."

Masato Yamada, Head of the Machining Technology Center, Development Division.

Improving customer services

The Machining Technology Center was envisioned to meet the need for comprehensive product solutions that would reflect on the extensive experience and skill accumulated by Mitsubishi Materials, enabling us to improve customer services. The planning started in 2008 and after two years of careful preparation the Center opened in April 2010. The extensive repertoire of solutions now provided by the Center includes unique machining programs that incorporate cutting tests and advanced CAM tool paths, direct telephone consultations, on-site presentations and a full range of technical services. Each month the Center receives close to 2,000 calls from customers seeking consultation, while Center staff call on approximately 230 clients to provide routine technical services. The Center's wide variety of human resources share a passion for development, production technology and marketing, while actively spreading the wealth of knowledge and advanced technology throughout the Company. The practice of Open Innovation through collaboration with universities, research institutions, machine tool manufactures and other external entities allows continuous improvement in the ability to develop solutions and make proposals that not only meet, but exceed customer expectations. All this helps to provide an excellent level of service that matches industry expectations.

Delivering leading edge knowledge and technology

The Machining Technology Center is planning to double the amount of machining centres and combined processing machinery by the end of 2016. Additionally, the development of new tools and machining strategies is also a key part of what the centre aims to achieve. In charge of this project is the new tool development team. Established in April 2015 the team is tasked with driving the development of tools and technology that will excite the market. In addition to the Machining Technology Center in Japan and technical centres in the US, Spain, China and Thailand, there are also plans for centres in Germany, India and South America. With the Machining Technology Center in Japan as a base, the idea is to enhance collaboration with technical centres in other countries to facilitate the provision of leading-edge services to customers. An example of the outstanding service, a system is in planning whereby a customer in the US can ask the technical centre in the US for a cutting test, this can be handled by the technical centre in China overnight and deliver the results to the customer the next morning. As we strive to improve our knowledge and technology, the ultimate goal is to identify and address the needs of customers with leading-edge solutions.



Technical centres established across the globe

"Improving professional skills to better respond to the full spectrum of customer consultation needs."

Yohei Araki
Machining Technology Center,
Development Division

Providing technological support

"When I first joined the company, I worked in sales and marketing for eight years before arriving at the Machining Technology Center in 2011. I am currently on the Cutting Test Team. This team requires a broad range of knowledge and skills, not only in machine operations, but also in machine programming. Initially there was a steep learning curve to overcome but I believe it allowed me to handle a broader range of work. What I always keep first and foremost in mind though, is the need to work from the customer's perspective. When customers ask us for cutting tests, they are obviously looking for improvements such as shortening of cycle times, improvements in precision and longer tool life. I also place a priority on completing each test quickly and accurately, submitting results on the day required. In addition to this there is also the need to accommodate the requests of the sales and marketing departments and contribute to the smoothness of overall business operations. I will continue to work on improving the skill and reliability of the Machining Technology Center for both customers and on-site staff. Our priority is based on providing outstanding services that satisfy customers' needs, and we are always looking ahead for future proof solutions."

A wide variety of solutions provided by the constantly evolving Machining Technology Center

1 Providing cutting tests, machining program proposals and other machining solutions.

2 Improvement of telephone consultation, technical trainings and other customer services.

3 Provision of easy to understand product information through seminars.

CUTTING EDGE

Hiroshi Watanabe
Solid tool R&D Centre

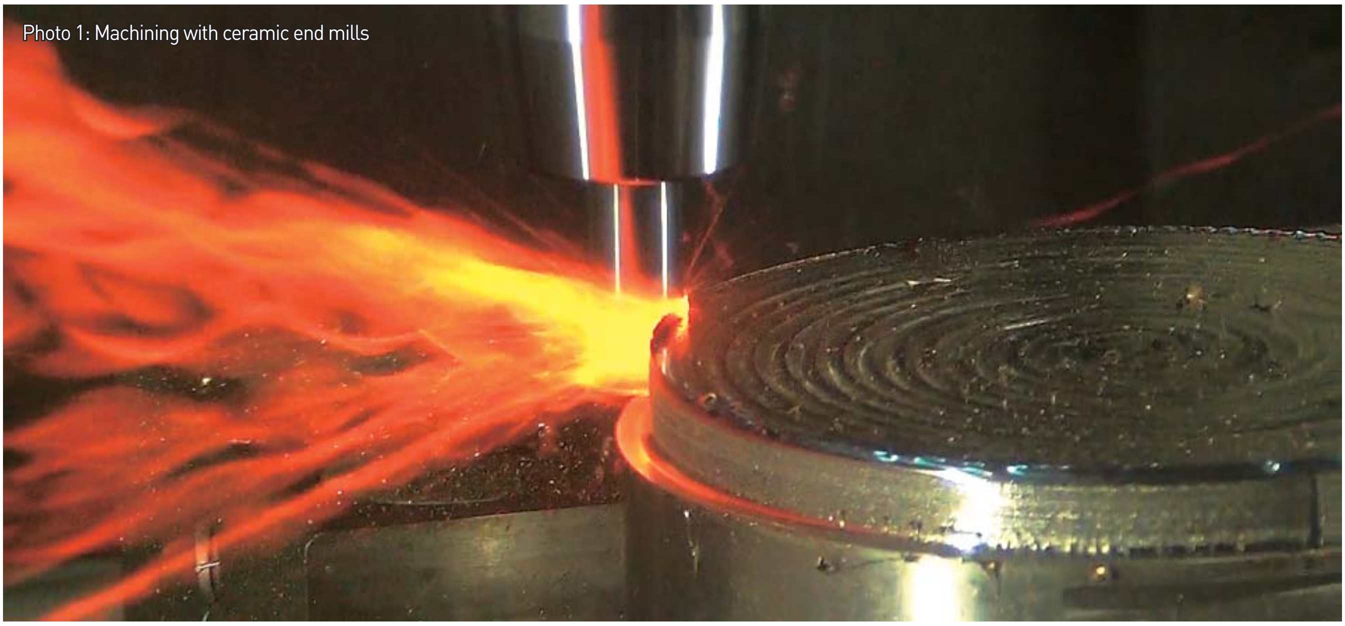
Vol. 1

Softening heat resistant alloys with heat

Excellent performance when machining heat resistant alloys

We are currently developing Ceramic End Mills capable of cutting materials at super-high speeds that existing cemented carbide end mills cannot match. To perform at these super-high speeds when machining heat resistant alloys, the end mills need to have outstanding resistance to the heat generated during this process. When cemented carbide end mills are used to machine heat resistant alloys it is necessary to reduce the heat generated to maintain tool life. This means that cutting speed is limited to around 70 m/min. However, with ceramic end mills the cutting speed can be 500 m/min or higher. This causes materials to be softened with the heat generated by machining. Although it sounds contradictory, heat resistant alloys soften at around 1,000 degrees C because bearing and tensile strengths are lowered in this temperature zone. While cemented carbide end mills cannot work at such high temperature, ceramic end mills can. This new ceramic end mill delivers outstanding performance when machining materials even whilst generating extremely high heat that produces red-hot chips (see photo 1).

Photo 1: Machining with ceramic end mills

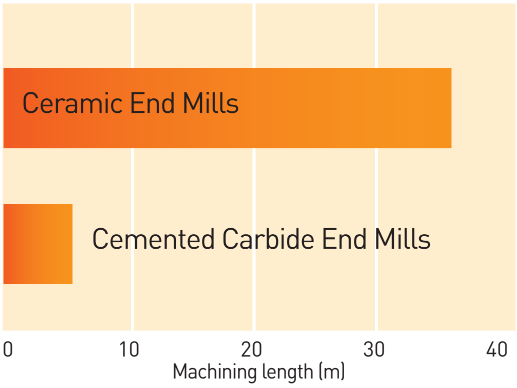


INCONEL® is a registered trademark of Huntington Alloys Canada, Ltd.

Excellent efficiency and tool life

Ceramic end mills machine heat resistant alloys in a completely different way than cemented carbide end mills. In fact, rather than "machining," it may be more accurate to describe the mechanism as "scarfing." The edge of the tool welds slightly but does not suffer significant damage because ceramics have outstanding resistance to the heat generated during machining. Therefore, compared with cemented carbide end mills, ceramic end mill tool life is significantly longer. Furthermore, cemented carbide end mills commonly break in the early stages of machining, but ceramic end mills can process up to 35 m (see Fig. 1). Cemented carbide end mills are not designed for such high-efficiency cutting at high speed, but ceramic end mills are, which gives them a distinct advantage (see Fig. 2). However, when using ceramic end mills the emphasis is placed on the challenging requirements of the machine tool. This is because of the speed required to generate the heat needed to soften materials without causing abrasion or other damage. Therefore, machine tool spindles must be capable of handling high revolutions and it is for this reason machining with ceramic end mills requires the best quality machine tools.

Fig. 1: Comparison of Tool Life



Condition of the edge after 30 m machining

Fig. 2 Machining Conditions

Work material	INCONEL® 718
Tool	4-flute Radius End Mill, φ 10 × R 1.25
Revolution	20,000min^{-1} (628m/min)
Feed rate	2,000mm/min (0.025mm/tooth)
Depth of cut	ap=7.5 mm, ae=3.0 mm
Overhang	23 mm
Machine	Vertical machining centre HSK-A63
Cutting method	Down cut, dry air blow

Further utilisation of ceramic end mills

I was involved from the early stages of product development and soon realised it was a challenge to identify the ideal machining conditions. Unfortunately repeated breakage and abrasion damage prevented sufficient product evaluation. However, with commitment towards finding the best ways to exert the potential performance of ceramic end mills, continued testing meant that the answers were finally found.

"Kohada, please!" "Coming right up!"

The master sushi chef makes your order right before your eyes, and it's a treat to watch him as he translates years of training and experience into something delicious.

Nineteenth-century Edo (Tokyo) was filled with sushi stalls, old Japan's version of modern-day fast food; and the stalls were crowded with people who stopped for a quick bite to eat, with hungry customers paying the equivalent of 150 to 200 yen (€1.00 - €1.50) in today's currency for each piece. Sushi was a common lunch for merchants.

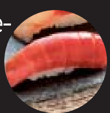
Some say that sushi evolved from Nare-zushi, a food brought from the neighboring Asian continent in the 8th century. Nare-zushi was fish and rice fermented with lactic acid. The process of fermentation liquefied the rice but the fish was removed and eaten. In the 13th century, fermenting time was reduced and people started eating both the fish and rice, which was called Nama, or "raw"nare-zushi. By the 14th century, Oshi- and Haya-zushi had appeared. Oshi-zushi was salted fish on rice, and Haya-zushi was vinegared rice.

It was around 1820 that the sushi we know today made its appearance and a man called Yohei Hanaya is credited with its introduction. Hanaya had a stall at the fish market in Nihonbashi, located just north of the now internationally renowned Tsukiji market. Nihonbashi is on Tokyo Bay, then known as Edo-mae, and supplied the area with fresh fish and shellfish such as spotted shad (Kohada), sea bream (Tai), perch (Suzuki), tiger prawn (Kuruma-ebi), conger eel (Anago) and clam (Hamaguri). Though before refrigeration was invented fish was either stewed, marinated or fried.
The ice-making technology developed at the end of the 19th century revolutionised our ability to preserve; and the ability to keep the fish catch cool started Hanaya on a journey to explore ways of bringing out the taste of fresh fish, a journey that culminated in the sushi that the world has come to know and love. As the popularity of sushi as a perfect match with sake spread during the post-war period, sushi masters strove to develop techniques that would bring out the best flavour of the sushi they prepared and it has since evolved into an art.

It takes at least 10 years to become a sushi master. In their first year apprentices are not even allowed to use a knife; and it's not until their seventh year that they are allowed to actually work with tuna. The vast majority of what these hard-working apprentices learn in their long years of training has to do with preparation. The artistic flow displayed in front of us when we place our order is only part of their technique.

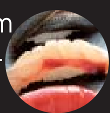
Four Traditional Types of Edo-mae Sushi

Marinated Tuna – Zuke-maguro



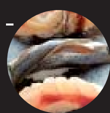
Zuke means marinated in soy sauce, sweet sake (Mirin), sake and Japanese soup stock. The salt in the soy sauce reduces the water content in tuna, which softens the flesh while maintaining its flavour. It is hard to cut tuna properly and if not done correctly, it will break into pieces. Tuna is a high-grade fish and it takes years for apprentices to become ready to prepare it.

Sandwiched Sea Bream between Sheets of Kelp – Tai no Konbu-jime



Kobu-jime is salted white flesh with salt placed between kelp. The salt and kelp draw moisture from the fish, tightening the fish and making it more sticky and tasty; and the kelp gives a deeper flavor to the light fish flesh. The type and thickness of kelp and the time it is allowed to sit significantly influences flavor and texture.

Spotted Shad Vinaigrette - Kohada no Sujime



This shiny fish is marinated in vinegar and salt, the vinegar has the effect of softening the outer skin of fish. Based on the weather and the amount of fat in the fish, sushi masters decide how much salt to use. Highly developed techniques such as scaling or the ability to slice the flesh into equal halves produces a texture that moves you when it is eaten. This is why people say that one bite of spotted shad is enough to judge the skill of the sushi master.

Stewed Clams – Ni-hama

Stewing calms so that they remain soft requires that they be placed in cold water and then heated. First they are boiled to about 65% completion and then placed in hot sauce until they are about 95% boiled. This requires experience and concentration. The finishing sauce is called Tsume, which takes three days and three nights to cook, slowly adding conger eel sauce during the time.

Sushi combines the collective wisdom of people that have been eating fish for centuries, a heightened sense of hospitality and the deep sophistication of Japanese cuisine. Let's share some of the skills sushi masters bring to their delicious art.

Making sushi

The sushi master dips his fingertips into a mixture of half vinegar and half water, and then takes some rice and forms it into an oblong block. The amount of rice used for individual pieces varies from restaurant to restaurant.

The master holds a slice of fish in his left hand, takes a dash of Japanese horseradish and spreads it on the slice of fish with his right forefinger. A little more horseradish is used on fatty cuts.

Then, the master places the oblong block of sushi rice on the slice of fish and presses the rice with his left thumb.

He then places his left thumb on the edge of the rice and wraps his left fingers around it to gently press both sides of the rice. At the same time, he places his right forefinger on the top of the rice to press and spread the rice vertically.

He then places his middle finger of his right hand on the left side of sushi rice and turns it over. (Now the fish is on the top.)

He presses both the right and left sides of the fish with the thumb and middle finger of his right hand.

Repeating step (4), he gently presses the rice and fish once more.

Holding the fish on the rice, he then rotates the piece 180 degrees.

He lightly presses the piece once again. Then he places the piece in front to you. The goal is to ensure that the rice separates smoothly as soon as it is put it in your mouth.

Eating sushi

Place your chopsticks on the top and bottom of the sushi and hold it horizontally.

Dip the edge in soy sauce, top down, and eat

You can also use your fingers.

Table manners at a sushi restaurant

If you order a la carte, explore different toppings.
Eat the sushi as soon as it is served to enjoy it at its best.
Don't stay too long if you're just ordering side dishes and drinks.
It's considered inappropriate for restaurant guests to use words commonly used among sushi chefs. So avoid asking for Agari when you want green tea, or Murasaki when you want soy sauce.

In cooperation with: "SUSHI KAISHIN", 1-15-7 Nishiazabu Minato-ku Tokyo, Japan

YOUR GLOBAL CRAFTSMAN STUDIO

Editor's Notes

We are pleased to introduce the first issue of Your Global Craftsman Studio and would like to express our deep gratitude to everyone for their hard work and unfailing commitment to bring the project to life.
From the start the editorial staff had two goals: firstly, to create a magazine that would be of interest to everyone involved in manufacturing, and secondly, to successfully convey the passion of craftsmen involved in the manufacture of the products that are made in Japan. We want to share some interesting stories with our readers about our culutre, craftsmanship and the craftsmen's passion and commitment to their work.
Moving forward we will continue our quest to uncover surprises and spread excitement in the world of craftsmanship.

"Your Global Craftsman Studio"
The Chief Editor; Hideyuki Ozawa
(Business Development and Planning Department)

Your Global Craftsman Studio
Vol.1
April 2015 Issue
Published by Business Development and Planning Department, Mitsubishi Materials Corporation

YOUR GLOBAL CRAFTSMAN STUDIO 001

Mitsubishi Materials is not just a tool manufacturer

We are committed to responding promptly to customers' challenges and to actively contribute to their success with the dedication of a professional craftsman.

We will strive to become the only tool manufacturer globally offering "your personal craftsman studio", a unique service for our customers.

It is the place where you can:
Find state-of-the-art technologies and products.
Find solutions, anytime, from anywhere in the world.
Share our excitement about the latest technology trends and product innovation.

It is the studio where we think, share, create and develop together with our customers, exciting solutions to meet their specific needs.

YOUR GLOBAL CRAFTSMAN STUDIO
MITSUBISHI MATERIALS

YOUR GLOBAL CRAFTSMAN STUDIO

The meaning of our logo

Our logo shows people, standing on a circle, holding hands. The circle represents the earth. Holding hands reflect our commitment to grow and succeed "hand in hand" with our customers and closely work with them to improve performance across the globe. The shape of the logo embodies a variety of ideas. It captures the image of "cutting tools" combined with the dominant letter "M" of the Mitsubishi Materials brand name. It also depicts a flame that symbolises our passion for craftsmanship.

MITSUBISHI
MITSUBISHI MATERIALS

(4 XXX)
PRINTED IN GERMANY

Mitsubishi Materials | Advanced Materials & Tools Company
www.mitsubishicarbide.com