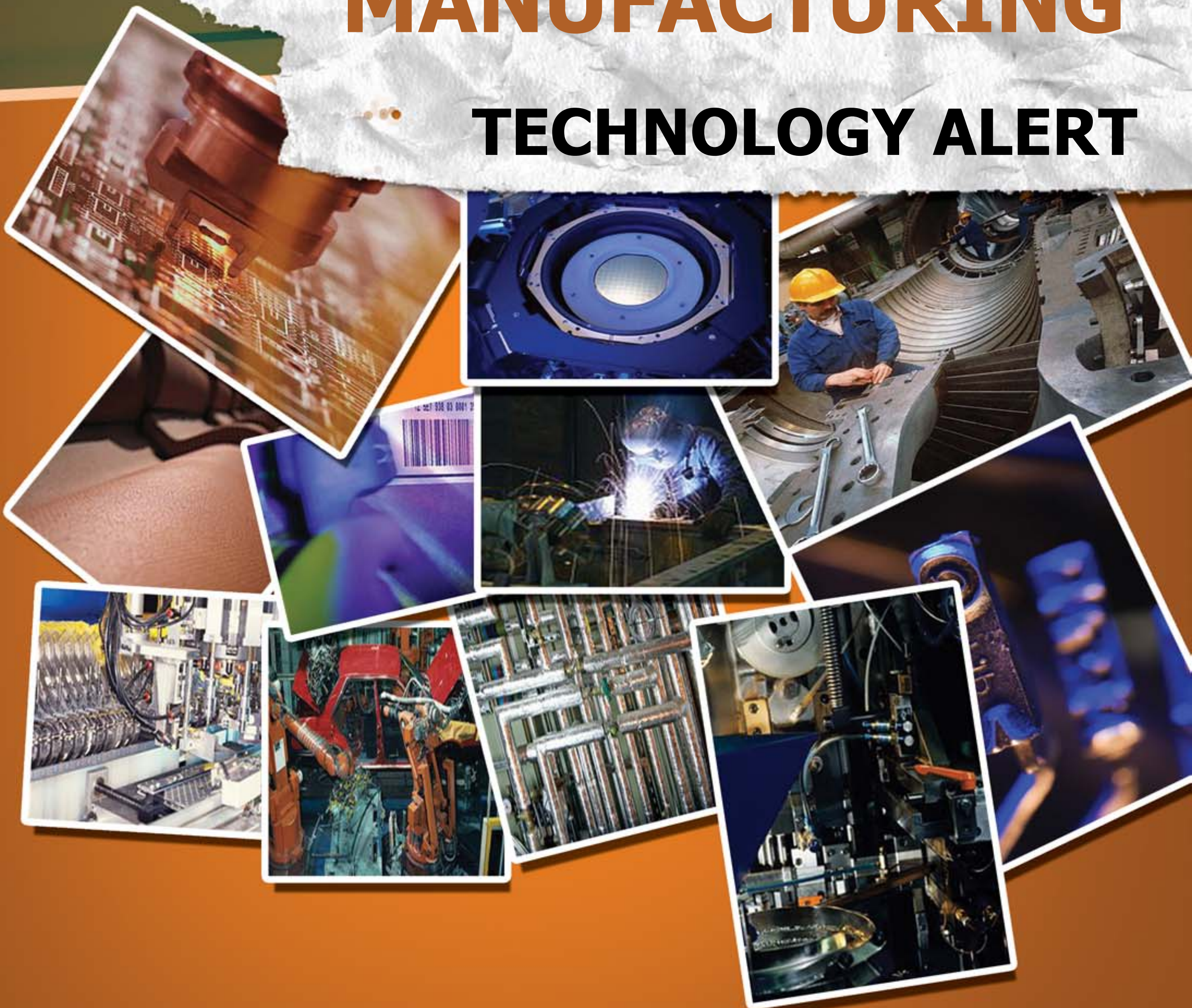
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



09th January 2015

1. PLASMA THERMAL SPRAYING FOR METAL HARDFACING APPLICATIONS

Many manufactured articles need hardfacing as a means to boost surface durability under demanding and abrasive field conditions. The underlying structure can be ductile and forgiving mild steel. For example, construction, farm, and mining machinery often need such hardfacing treatment for ground-engagement implements. Engineers have a choice of hardfacing methods and materials, such as thick weld overlays, thermal flame sprayed coatings, and plasma thermal spray coatings.

Typical plasma spray hardfacing materials include nickel-and cobalt-based metal alloys, high-temperature refractory metals, and ceramics. Among all the hardfacing technologies, only plasma spray gets hot enough (10,000 degrees K) to immediately melt and project ceramic materials onto a target surface. Engine exhaust system ceramic coatings are a good application for plasma spray, which provides both a thermal barrier and a hard coating to resist wear. For certain oxygen-sensitive coating applications, the plasma spray must be applied in a vacuum chamber.

The plasma spray process works as follows: powder or wire coating feedstock is fed into the nozzle or plasma torch, where an electric arc is struck with the help of an external high-voltage DC power supply. Alternatively, AC power driving a radio frequency (RF) coil can heat up the plasma. There is a plasma gas flowing with the molten droplets. The molten droplets hit the target surface, flatten out like pancakes, and build up into an adherent coating consisting of layers of lamellae. The deposit is not 100% solid and continuous: there are small defects, such as voids, cracks, and pores. Because the rate of solidification is so high, metastable phases can form. Such phases, which are common in freezing liquids, are temporarily at a state of energy higher than the least energy state. They may reduce their energy state later.

Exhibit 1 depicts Ford Shelby GT-500 5.4 liter V-8 engine block with PTWA bore lining.

Picture Credit: http://www.greencarcongress.com/2009/05/ptwa-20090529.html

There is a special variant of the plasma process used to hardface engine cylinder bores in cast aluminum cylinder blocks, eliminating the need for heavy cast iron liners (see exhibit). In this plasma transferred wire arc process (PTWA), a single wire that conducts electric power becomes the feedstock. Then, a high-velocity (supersonic) plasma gas jet hits and melts the wire into an atomized spray projected at the working surface. Besides cylinder bores, many other engine parts can benefit from PTWA, including bearing surfaces. In the case of the Shelby GT-500 V-8 application shown, the hard composite lining applied by PTWA on the aluminum engine bores is only 150 microns (0.006 inches) thick.

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2. NOVEL TOOLKIT FOR DEVELOPMENT OF NEXT-GENERATION SOFT ROBOTS

With advancements in various manufacturing technologies, such as 3D printing, laser cutting and so on, soft robotics is gaining significant importance. By utilizing the principles from conventional rigid robot design and working with pliable materials, researchers are increasing the uses of soft robotics for a wide range of sectors, such as manufacturing, healthcare and so on.

Researchers from Harvard University, USA, in association with Trinity College, Dublin, have developed a novel toolkit consisting of intellectual raw materials that are required to design, build, and operate soft robots that are made using soft, flexible materials. The technology includes downloadable, open source materials consisting of procedures and training materials for users to design, fabricate, model, characterize, and control soft robotic devices. According to the researchers, this novel toolkit is said to provide researchers a significantly high level of detail, such as 3D models, bills of materials raw experimental data and so on. By creating a common resource for the sharing of various design approaches, prototypes, fabrication techniques, and technical knowledge, the developers aim to simulate the creation of novel types of devices, tools, and methods for manufacturing soft robots in the future. This toolkit is seen as a breakthrough, especially for soft robotics. It is well suited for design tools as many of the components, such as regulators, valves, and microcontrollers are largely interchangeable between systems. The researchers believe that this toolkit could be of significant importance as an educational source. For instance, the design modules included in this toolkit would be helpful for students and other researchers, guiding them with their work, capturing the expertise of other researchers in the field, and making it accessible for students. An open design hardware platform such as this new toolkit when coupled with the advances in computer-aided engineering is seen to have significantly high potential for developing remote collaboration on various mechanical engineering projects. The above-mentioned enhancement will allow newer innovations in robotics and other fields of mechanical engineering.

The advantage of this novel toolkit is that it has the potential to bring about various innovations in the field of soft robotics, which is gaining wide-scale adoption in various industrial sectors. Offering such a range of capabilities, it has potential to be adopted by a significant number of universities and research organizations, and further development of the product is expected in the future.

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3. INNOVATIVE MACHINE MONITORING SYSTEMS FOR MANUFACTURING

Metal forming machines are subjected to various forces and withstand these forces for long periods of time. For instance, cold forming parts for automobiles are subjected to forces that are significantly high. This operation is repeated a large number of times in the complete lifetime of a machine. If the machine fails, it can cause substantial damage. To increase the efficiency and lifecycle of machine parts, researchers are trying to develop monitoring systems that can be used for monitoring and maintenance.

Researchers from the Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany are developing a technology that would allow machines of the future to detect problems and failures well in time. Under the European Union project iMAIN, the researchers have developed a prototype of an information-based predictive maintenance system that enables operators to determine when a component or entire plant is likely to fail. The virtual sensors employed in this technology are a prominent feature. The sensors receive inputs from both from computer-simulated models of the machine and from real sensors, thereby providing information about the strain that is occurring on individual components. According to the researchers, the use of the real-time sensors instead of the mathematical models has enabled them to gather and simulate real-time scenarios of the strains that are caused on the entire machine. This information in turn provides the basis for an entirely novel approach for predictive maintenance of the machines. Currently, plant maintenance tends to be carried out through a fixed schedule or on the basis of failure responses. Although certain key participants in the market equip their machines with sensors, the drawback seen with the current systems is that they are expensive and complicated to implement. The other disadvantage is that the current monitoring systems measure stress and strain only at the points where they are installed. According to the researchers from Fraunhofer, the novel technology is cost-effective and less complicated besides offering higher efficiency levels compared to the systems currently available in the market. The data obtained from the monitoring systems using the technology can be accessed by users in factory floors through their smart phones, tablets, and laptops, which store information on the stress history of various machines in the factory. The data collected over time could be used by the company to calculate the breaking point of various materials and machines.

Due to the above-mentioned capabilities and features, this innovation has the potential to be adopted on a significant scale once it is commercially available in the market.

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4. PATENT ANALYSIS OF ARC WELDING

Arc welding is a welding process in which welding power supply is used to create an electric arc between the electrode and the base material to melt the metals at the welding point. The process can use either direct current or alternating current as the power source to create the arc. It is an important process in the fabrication of steel structures.

A recent patent in arc welding, US8809736 B2, is assigned to Panasonic Corporation and pertains an arc welding method and apparatus that allows the output voltage to be matched with the set voltage, and stabilizes the arc.

Varied patents have been filed on the arc welding process by the following companies, Panasonic Corporation, Kobe Steel Ltd., and Daihen Corporation.

Many companies are working on arc welding methods and apparatus. Examples include Panasonic Corporation's patent on a new consumable electrode arc welding method and consumable electrode arc welding device (US8513568 B2), Taiyo Nippon Sanso Corporation's patent on a new method for tandem gas metal arc welding (US8461471 B2) and Daihen Corporation's patent on a new pulse arc welding method (US8203100 B2).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Arc welding method and arc welding apparatus	19 Aug 2014 / US8809736 B2	Panasonic Corporation	Junji Fujiwara, Yasushi Mukai, Atsuhiro Kawamoto, Masaru Kowa	An arc welding method of the present invention controls a short-circuit current increasing gradient (di/dt), an inflection point at which the short-circuit current increasing gradient (di/dt) changes, the current in a peak period and in a base period, and the time of the peak period in accordance with a difference between a set voltage and an output voltage. This allows the output voltage to be matched with the set voltage, and stabilizes the arc. Thereby, a stable arc welding method can be implemented, even as a method for outputting a welding current based on a welding voltage.
Robot controller that controls tandem arc welding system, arc tracking controlling method using the robot controller, and the tandem arc welding system	3 Jun 2014 / US8742292 B2	Kobe Steel, Ltd.	Atsushi Fukunaga, Takeshi Koike	A robot controller that controls a tandem arc welding system according to the present invention includes a leading-electrode correcting section that calculates a leading-electrode correction amount, used for correcting a displacement in a left-right direction and an up-down direction, from a leading-electrode changing amount calculated by a leading-electrode processing section; a leading-electrode correcting section that calculates a trailed-electrode correction amount, used for correcting a displacement in a rotational direction, from a trailed-electrode changing amount calculated by a trailed-electrode processing section; a rotational-displacement correction controlling processing section that calculates a rotational-center correction amount for correcting the displacement of the leading electrode; and a robot trajectory planning processing section that corrects a teaching position and a position of a rotational center of a welding torch during tracking correction. By such a structure, even if arc tracking is carried out at any rotational center, displacement of the leading electrode does not occur, so that defective welding does not occur.

Arc welding power source	5 Nov 2013 / US8575516 B2	Daihen Corporation	Futoshi Nishisaka, Akihiro Ide, Tetsuo Era, Hiroyasu Mondori	An arc welding power source supplies a start current, a welding current and a crater current as an output current in accordance with an activating signal supplied from outside. The power source includes a start period setting unit, a crater period setting unit, and a current control unit that controls the output current. The current control unit causes the power source to supply the start current and the welding current consecutively while the activating signal is in an on-state, where the start current is supplied for the start period, and the welding current is supplied for the period following the start period. The current control unit also causes the power source to supply the crater current after the activating signal is turned off, where the crater current is supplied for the crater period.
Arc welding method	17 Sep 2013 / US8536487 B2	Kabushiki Kaisha Yaskawa Denki	Seigo Nishikawa, Kanji Katada, Hirotaka Adachi, Tsuneo Shinada, Hideyasu Machii	A consumable electrode type arc welding method for generating arc between a plate-shaped work and a welding wire by a mixed shield gas including argon gas to weld the plate-shaped work, includes: • making a state of reverse polarity in which the polarity of the welding wire is positive at the welding start time, and • switching at least once to a state of positive polarity in which the polarity of the welding wire is negative.
Consumable electrode arc welding method and consumable electrode arc welding device	20 Aug 2013 / US8513568 B2	Panasonic Corporation	Atsuhiro Kawamoto, Yasushi Mukai, Junji Fujiwara, Toshiyuki Mishima, Masaru Kowa	If a short circuit does not occur during deceleration of a wire feed speed in forward feed of a welding wire before the wire feed speed reaches a predetermined wire feed speed, a cyclic change is stopped and the wire feed speed is constantly controlled at the first feed speed. If a short circuit occurs during forward feed at the first feed speed, deceleration from the first feed speed starts, and the cyclic change is resumed for welding. This achieves uniform weld bead without increasing spatters even if any external disturbance such as change of distance between a tip and base material occurs.
Systems and methods to modify gas metal arc welding and its variants	22 Oct 2013 / US8563896 B2	Yu Ming Zhang, Jinsong Chen	Yu Ming Zhang, Jinsong Chen	A welding system and method includes a main torch including a main electrode configured to form a first arc with a base metal; a first bypass torch including a first bypass electrode configured to form a second arc with the main electrode; and a second bypass torch including a second bypass electrode configured to form a third arc with the main electrode.

AC pulse arc welding method	6 Aug 2013 / US8502114 B2	Panasonic Corporation	Yukinori Hirota, Hiroki Yuzawa, Masaru Kowa, Hideki Ihara	An AC pulse arc welding method of the present invention sets an appropriate AC frequency based on a wire feed rate and a polarity ratio when the polarity ratio is changed without changing the wire feed rate to control a heat input to a base material, and sets an appropriate straight polarity current value necessary for one drop per pulse from the polarity ratio and the AC frequency in AC pulse welding. The method makes it possible to achieve appropriate AC pulse welding by setting the polarity ratio, and to easily set the welding conditions.
Tandem gas metal arc welding	11 Jun 2013 / US8461471 B2	Taiyo Nippon Sanso Corporation	Yuichiro Enatsu, Makoto Takahashi	The present invention provides a method for tandem gas metal arc welding using a leading electrode and a trailing electrode, wherein a shielding gas for the leading electrode is a two-component mixed gas containing argon and carbon dioxide, or a three-component mixed gas containing argon, carbon dioxide, and oxygen; a shielding gas for the trailing electrode is argon, a two-component mixed gas containing argon and carbon dioxide, a two-component mixed gas containing argon and oxygen, or a three-component mixed gas containing argon, carbon dioxide, and oxygen; and the concentration of carbon dioxide in the shielding gas for the trailing electrode is lower than the concentration of carbon dioxide in the shielding gas for the leading electrode.
Pulse arc welding method	19 Jun 2012 / US8203100 B2	Daihen Corporation	Yuji Ueda	A pulse arc welding method is provided for performing welding by causing welding current to flow through a welding wire and a base metal via a power supply tip. The welding current has a pulse cycle made up of a first peak time, a second peak time and a base time. A first peak current is applied during the first peak time, a second peak current, smaller than the first peak current, is applied during the second peak time, and a base current is applied during the base time. When a tip-base distance between an end of the power supply tip and the base metal is smaller or greater than a reference value, the first peak current is increased or decreased in accordance with the difference between the reference value and the tip-base distance.
Data processing apparatus for arc welding	8 Jun 2010 / US7734358 B2	Fanuc Ltd	Atsushi Watanabe, Yoshiharu Nagatsuka, Toshiya Takeda	A data processing apparatus for processing data described in a welding operation program of an arc welding robot system. The data processing apparatus includes a data obtaining section for obtaining a plurality of position and orientation data at a plurality of different teaching points previously taught and included in the welding operation program; a reference plane setting section for setting a virtual reference plane as a reference defining a geometric placement of an arc welding torch relative to a workpiece during a welding operation, based on the position and orientation data obtained in the data obtaining section; an angle calculating section for calculating a plurality of angle data representing the geometric placement of the arc

				welding torch at every teaching points, by using the position and orientation data obtained in the data obtaining section and the virtual reference plane set in the reference plane setting section; and an angle processing section for performing at least one of a displaying process and a correcting process of the angle data calculated in the angle calculating section.

Exhibit 2 depicts patents related to arc welding.

Picture Credit: Frost & Sullivan

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