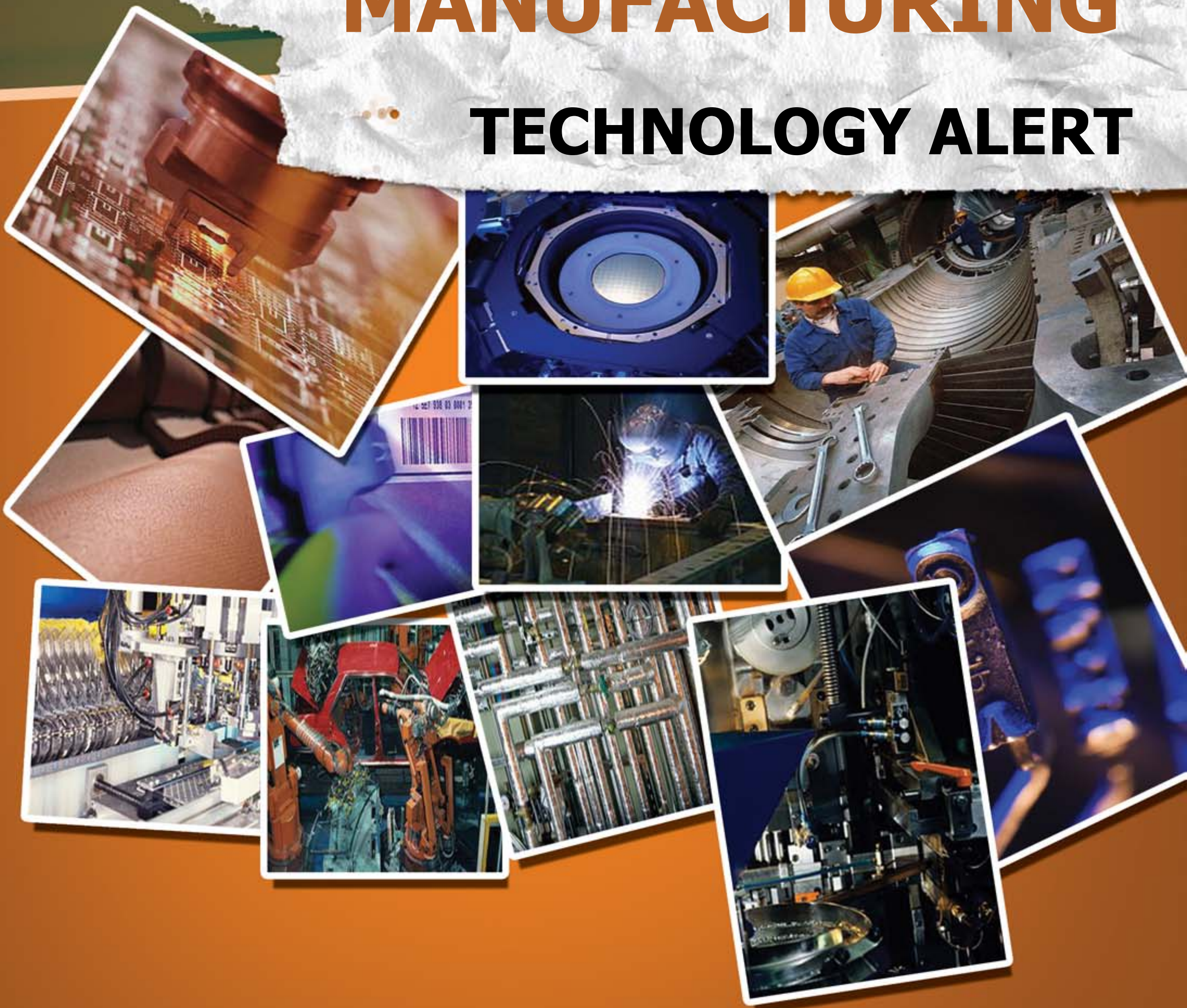
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



22nd May 2015

1. NOVEL MANUFACTURING PROCESS FOR DEVELOPMENT OF SOFT ROBOTS AND MACHINERY FOR THE INDUSTRIAL SECTOR

A group of researchers from the school of mechanical engineering at Purdue University has developed a novel manufacturing technique that could be used for developing soft machines from elastic and liquid materials. These soft machines are expected to be used for potential applications such as robotics, medical devices, and consumer electronics. According to the researchers, this technique would enable the production of robots having a sensory skin and of stretchable garments that people could use for interacting with computers and other therapeutic purposes. The researchers are also working on developing a fabrication technique that could be used in a custom-built three-dimensional (3D) printer. The method developed by the researchers takes advantage of materials such as alloys that are commonly used for manufacturing soft machines.The researchers embedded liquid-alloy devices into a rubber-like polymer, polydimethylsiloxane, or PDMS, which is a silicon-based elastomer. Liquid gallium-indium alloy was then used to create patterns of lines for forming a network of sensors. But the drawback with the gallium alloy is that it forms into a thick gallium oxide skin, thereby making it difficult to work with using the conventional liquid processing techniques. Using the method, the researchers exploited the structural stability of the oxide, thereby enabling them to print liquid on a surface, which helps in stabilizing the structure of the product. With this finding, researchers were able to embed the electronics in elastomer without altering the printed structures during the processing steps. Based on the findings from their experiments, a soft strain gauge was developed using this novel manufacturing technique. As the conventional strain gauges were made of rigid thin film, they could not be used for measuring more than 1% of deformation without breaking, whereas the soft strain gauge is said to stretch along with the material of the product that is being tested. This feature of the soft strain gauge allows it to measure 100% of the material's strain. Another key factor of this soft strain gauge is that it can be used for detecting very high strains and also can deform with any material.

One of the other potential applications for this novel manufacturing technique is that it can be used for manufacturing sensors. Prototypes of sensors using this novel manufacturing process have also been developed by the researchers. This method has enabled the digital fabrication of the sensors on a micro scale. Pressure sensors, capacitors, and conductors are some of the products that could be manufactured using this novel method.

Another advantage of this manufacturing method is that it could be used for developing new types of soft microelectromechanical systems (MEMS) for consumer electronics, automotive airbags, and other products; such MEMS are currently made with solid metals. The development of soft MEMS could have a lot of novel applications in the future. Due to the above-mentioned advantages and capabilities, this innovative manufacturing method has opportunities to be adopted on a significant scale for manufacturing various products that are used in different industrial sectors.

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2. 3D PRINTED JET ENGINE USING ADDITIVE MANUFACTURING PROCESS

Additive manufacturing is helping to drive the future of manufacturing. The evolution of three-dimensional (3D) printing and additive manufacturing has impacted the manufacturing processes in various industries. In the automotive and aerospace industries, additive manufacturing has enabled production of parts and components that are on par with parts manufactured using traditional methods. Additive manufacturing also enables creation of complex parts that would be difficult to manufacture using conventional techniques. Indicative of the increased acceptance and adoption of additive manufacturing in the aerospace sector, General Electric's aviation division has 3D printed an aircraft engine.

Engineers at GE Aviation's Additive Development Center near Cincinnati, Ohio, have used 3D printing to create a mini-jet engine that is capable of performing 3,300 rotations per minute. This engine was manufactured by employing additive manufacturing techniques that built layers on layers of melting metal powder.

This additive manufacturing method adapted by GE uses electron beam of a laser to 'print' the parts by accumulating layer over layer of refined metal powder. The 3D structure is sourced from a computer aided design (CAD) file. This combination of laser and 3D printing resulted in creating parts that are intricate and dense. Also, this approach reduces a significant amount of the time taken by conventional manufacturing methods, without generating waste.

In the recent past, General Electric has been exploring the potential of additive manufacturing and extending its benefits to its manufacturing units. One of the engineers in the team explained that in order to explore the additive manufacturing techniques for making parts for jet engines, a team of technicians, machinists, and engineers was constituted. However, the team went on to explore if it could build a small engine using additive manufacturing techniques. They decided to use an additive manufacturing process called DMLM or direct metal laser melting to make the small engine. This process seemed more relevant to the team because it could be configured to redesign the parts with new geometries.

One of the researchers explained that the process DMLM used by them is popularly known as selective laser melting, selective laser sintering or direct metal laser sintering. But the GE team has used the term 'melting' because they inferred that the machines used in this process fused the layers of materials more in the welding fashion rather than sintering. Also, the mechanical properties of the product delivered by this process are better than the properties of the cast, which would have developed as a result of sintering.

The team believes that additive manufacturing can create intricate geometries that cannot be achieved by any other method. The aerospace industry, in particular, benefits highly because of additive manufacturing's unique ability to create complex geometries from materials such as nickel-based alloys and titanium, which are used in aerospace engineering. The parts and structures created by this process are lightweight and have the same mechanical properties as the structures created by conventional methods.

The engineering team began by designing a radio-controlled aircraft engine, the engine usually used in model planes controlled by remote control. The model aircraft is about 8 inches tall and has a length of about 1 foot. This is a simple commercial aircraft engine and the team altered the design to be fed to the printing machine.

After a successful flight of this model aircraft with 3D printed engine, GE Aviation reckons that additive manufacturing will change its approach to designing and manufacturing new parts moving forward.

The company is now focusing on using additive manufacturing to produce intricate parts of aircraft. It claims that the additive manufacturing process will be used to manufacture components of its newly designed fuel nozzles later this year. The new fuel nozzles are very complex and mature, have abilities to deliver the desired performance with fewer emissions, and are highly efficient in fuel usage. The production will take place in its facility in Auburn, Alabama. The new GE nozzles will be placed in GE's LEAP engines.

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3. NEED FOR MULTIMATERIAL JOINING TECHNOLOGIES IN THE AUTOMOTIVE SECTOR--STRATEGIC INSIGHTS

Lightweighting of vehicles is a trend that is growing fast in the automotive industry. The increasing importance of lightweight products has led companies to look into the adoption of lightweight material alternatives for their products. However, joining of these materials is turning out to be quite a challenge, for which a number of companies and research institutes are currently trying to find a solution. The automobile sector has developed a keen interest in multimaterial joining technologies, which would allow reducing fuel consumption, carbon emissions, as well as the overall weight of vehicles.

The above-mentioned factors are seen as the major reasons for the growing trend of exploring novel methods of lightweighting by automobile manufacturing companies across the globe in order to efficiently keep their production costs low, while also reducing fuel consumption. With the emergence of new application areas for light metals, it has become important to benchmark all these materials with respect to the amount of weight saving and the cost involved in replacing the incumbent materials. It has been found that magnesium and carbon fiber composites are among the highest weight savers, but have higher cost factors. Glass fiber composites have cost factors on the lower side, and weight saving is also high; but there are safety issues restricting their major penetration. HSS (high-strength steels) and AHSS(advanced high-strength steels) are also sustaining solutions that reduce cost and weight to some extent. According to a study funded by the US Department of Labor's Employment and Training Administration, the use of regular steel and iron is seen to have reduced by close to 40% from 50% over the years. At the same time, the use of plastics is seen to have increased rapidly. However, there has not been much difference in the weight of automobiles. Rather, the average weight of the automobiles has been increasing over the past few years. This indicates that the automotive industry in the United States, and even globally, may not have focused strongly on developing multimaterial joining technologies, which are essential for adoption of lightweighting materials. However, the interest in adoption of lightweighting materials is keen in the industry, leading to a strong interest in development of multimaterial joining technologies.

Government bodies across the globe are now looking for newer ways to increase fuel efficiency and reduce the emissions of vehicles employed in road transport. Countries such as USA and nations in EU have stringently imposed penalties if fuel efficiencies and emission norms are not being met. In Japan, the weight of vehicles is also a key factor for meeting the fuel and emission standards, but the penalties for the manufacturers who don't meet the standards are relatively low compared to USA and EU. The penalties are expected increase in the coming years as the Japanese government is looking seriously into increasing its fuel efficiency. One key feature of the Chinese standards is that rather than being based on fleet average, they have maximum allowable fuel consumption limits by weight category. Each of the vehicle models sold in China is expected to meet the standard for its weight class, which has resulted in companies adopting various multimaterial joining technologies on a larger scale compared to the other regions. Overall, there is a huge push in the automotive industry to adopt lightweighting technologies and reduce vehicle weight. In this regard, a number of automotive OEMs and material suppliers are working toward developing and adopting novel methods of lightweighting technologies. One of the key challenges associated with lightweighting is the lack of suitable multimaterial joining technologies. With the advancement of the multimaterial joining technologies as seen currently in the market, various lightweighting technologies are expected to be adopted on a large scale by a large number of automotive companies across the globe. These innovations are expected to help the companies to develop vehicles that are lightweight and also meet the government norms for fuel efficiency and emissions, which are expected to become more stringent with time.

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4. PATENT ANALYSIS OF LASER WELDING PROCESSES

Laser welding is a popular welding technique that uses powerful laser beams to join metals in production facilities that handle high-volume output, for instance, the automotive industry. Generally, this welding method is used in joining metals such as stainless and carbon steel, nickel, titanium or aluminum alloys.

This welding process is often preferred in metal joining for its extremely desirable properties such as high precision and cleanliness. Although, electron beam welding renders similar welds, the laser welding process is very flexible because it eliminates the need for using a vacuum chamber. However, laser welding equipment in industries can be expensive, and this can limit its adaptation. But, with the quality of the welds produced, it promises a quick return of investment (ROI) on these laser welding devices.

The exhibit below shows the patent analysis of laser welding technologies in the last two months (16 March to 16 May, 2015). The number of patents published in this brief period suggests the intensity of research activities in laser welding technology. New laser welding device and process patents filed by three large automotive companies--Hyundai Motor Company (laser welding device), Toyota Motor Co. (laser welding method) and Renault SA (transparent laser welding of parts)--is a clear indication of increased research being carried out in laser welding by the automotive sector.

The patents filed by Siemens Aktiengesellschaft (US 20150108097) pertains to the laser welding process for nickel super-alloys and the patent assigned to Mitsubishi Heavy Industries Ltd.(WO/2015/056453) relates to a new method for joining cylindrical metal bodies using laser welding.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
METHOD FOR MANUFACTURING BOILER WATER WALLS AND BOILER WITH LASER/ARC WELDED WATER WALLS	May 14, 2015 / US 20150128881	Chicago Tube and Iron Company	Peter T. Nance	A method of fabricating boiler water walls that includes the steps of forming a subpanel formed of at least one fin and one tube by laser arc welding the at least one fin to the one tube and then laser arc welding a predetermined plurality of subpanels together in a two-dimensional plane by laser arc welding an additional joining element between respective subpanels to form the water wall.
BLACK POLYMER COMPOSITION SUITABLE FOR LASER WELDING	May 7, 2015 /WO/2015/063413	ARKEMA FRANCE	BENET, Sylvain	The invention concerns a part comprising a portion suitable for being welded to a portion of another part by applying a laser beam, said portion of the part being transparent to the laser beam and said portion of the other part being absorbent for the laser beam, and said portion of the part being black and comprising at least one layer of a composition comprising a thermoplastic polymer and carbonaceous nanofillers.
LASER WELDING OF NICKEL-BASED SUPERALLOYS	April 23, 2015 / US 20150108097	SIEMENS AKTIENGESE LLSCHAFT	Nikolai Arjakine	In order to obtain crack-free, homogeneous welds in nickel-based superalloys, laser parameters in respect of the power, the beam diameter, the mass feed rate, and the speed of advancement, are specifically selected.
LASER WELDING METHOD, LASER WELDING DEVICE, AND CYLINDRICAL BODY	April 23, 2015 WO/2015/056453	MITSUBISHI HEAVY INDUSTRIES, LTD.	KAMITANI, Keisuke	In this laser welding method, the end sections of cylindrical bodies (5a, 5b) are placed against one another in the axial directions thereof, a groove section (6) is thereby formed along the circumferential direction, and welding is performed by applying a laser beam to said groove section (6). The laser welding method is provided with: a welding step (S2) in which welding is performed by applying the laser beam across the entire circumference of the groove section (6); and a warping correction step (S4) in which a laser beam that has a smaller heat input amount per unit area than the heat input amount of the laser beam that is applied during the welding step (S2) is applied across the entire circumference of the welded groove section (6).
Method of directionally post treating a welding seam during laser build up welding of a substrate	April 22, 2015 EU 2862663	SIEMENS AG	BURBAUM BERND	By way of the targeted selection of method parameters in laser welding, namely feed rate, laser power beam diameter and powder mass flow, the temperature gradient can be set in a targeted manner, which temperature gradient is decisive for the single crystal growth during laser build-up welding.
LASER WELDING DEVICE	April 16, 2015 US 20150102021	Hyundai Motor Company	Junkyoung Lee	A laser welding device may include: a frame including a lower die supporting at least two sheets of welding objects and an upper die mounted over the lower die to be spaced apart from the lower die; a pressing plate movably mounted on the upper die in a vertical direction and pressing the welding objects; a rotating member mounted on the pressing plate and rotating based on a pressing central shaft of the pressing plate; a tilting member disposed in a direction intersecting the pressing central shaft and connected to the rotating member to be tilted in a vertical direction; and a scanner head reciprocally mounted on the tilting member along a length direction, scanning the laser beam in an X axis and a Y axis, and irradiating the laser beam to the welding object.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
WELDING DEVICE, WELDING METHOD, AND METHOD FOR PRODUCING CELL	April 15, 2015 EU 2859986	TOYOTA MOTOR CO LTD	SUGIYAMA TORU	Provided is a technique by which, in laser welding, the desired weld penetration depth can be achieved without any oxide film lingering in the deep part of a weld pool. Provided is a welding device (1) for emitting a laser focused on a processing point (P). At the processing point, the laser has a profile similar to that of a superimposed laser formed by superimposing a first laser and a second laser having a smaller beam radius than that of the first laser. In the laser profile, a portion corresponding to the first laser has a power density of an extent enabling heat conduction welding, and in the laser profile, a portion corresponding to the second laser has a power density of an extent enabling keyhole welding.
SYSTEM AND PROCESS FOR TRANSPARENT LASER WELDING OF PARTS, EMPLOYING INDEPENDENT PROTECTIVE AND CLAMPING ELEMENTS	April 8, 2015 EU 2855077	RENAULT SA	KERBIGUET JEAN-GILLES	The present application describes a system for joining two parts (10, 11), comprising an element for projecting a laser beam (F), welding two parts (10, 11) at a contact interface (12) between the two parts (10, 11), and a clamping element (14) configured to transmit a force to an assembly (E) formed by the two parts (10, 11) to be welded. The system also comprises a protective element (15) that is independent of the clamping element (14) and configured so that the force exerted by the clamping element (14), during welding, is applied to the protective element (15) and transmitted by the protective element (15) to the assembly (E) of the two parts (10, 11). A joining process and an assembly made of two parts joined by such a process are also described.
LASER WELDING METHOD	April 10, 2015 RU 0002547987	-N.A-	IT , Koji	FIELD: physics. SUBSTANCE: laser welding is carried out by emitting two laser beams along a fusion line on the side of the upper surface of the processed component. The two laser beams are transmitted through different optical fibres with diameter of focused spots of 0.3 mm or more. The leading laser beam and rear laser beam of the two laser beams is inclined in the welding direction at an angle of incidence relative to the direction perpendicular to the upper surface of the processed component. The leading laser beam is ahead of the rear laser beam on the upper surface of the processed component in the welding direction. The rear laser beam is behind the leading laser beam. The angle of incidence of the leading laser beam is set greater than that of the rear laser beam. EFFECT: preventing sputtering and sticking to the upper surface of the processed component and the optical component during welding, preventing undercut or underfill of the joint on the back surface of the processed component. 3 cl, 4 dwg, 3 tbl, 2 ex
WELDING DEVICE COMPRISING AN ACTIVE HEATING DEVICE FOR HEATING THE WORKPIECE	March 26, 2015 WO/2015/039154	STIWA HOLDING GMBH	GRAUSGRUBER , Klaus	The invention relates to a welding device (1), in particular a laser welding device, for welding metallic workpieces (3), comprising at least one welding head (2), in particular a laser welding head, which defines a working area (4). The welding device is characterized by at least one heating device (5) which acts upon the working area (4) to heat up the workpiece (3), in particular before and/or after the welding process.

Exhibit 1 depicts patents related to laser welding.

Picture Credit: WIPO

5. TECHVISION 2015

The TechVision program is the premier offering of Technical Insights, the global technology innovation-, disruption-, and convergence-focused practice of Frost & Sullivan. TechVision embodies a very selective collection of emerging and disruptive technologies that will shape our world in the near future. This body of work is a culmination of thousands of hours of focused effort put in by over 60 global technology analysts based in six continents.

A unique feature of the TechVision program is an annual selection of 50 technologies that are driving visionary innovation and stimulating global growth. The selected technologies are spread across nine Technology Clusters that represent the bulk of R&D and innovation activity today. Each Cluster represents a unique group of game-changing and disruptive technologies that attract huge investments, demonstrate cutting-edge developments, and drive the creation of new products and services through convergence.

Our technology analysts regularly collect deep-dive intelligence on several emerging and disruptive technologies and innovations from around the globe. Interviews are conducted every day with innovators, technology developers, funders, and others who are a part of various technology ecosystems. The respondents are spread across public and private sectors, universities, research institutions, and government R&D agencies. Each technology is rated and compared across several parameters, such as global R&D footprint, year of impact, global IP patenting activity, private and public funding, current and emerging applications, potential adoption rate, market potential, and so on. This organic and continuous research effort spread across several technologies, regions, organizations, applications, and industries is used to generate an annual list of Top 50 technologies that have the maximum potential to spawn innovative products, services, and business models.

Furthermore, we analyse several possible convergence scenarios where two or more of the Top 50 technologies can potentially come together to disrupt, collapse, and transform the status quo. Driven by IP interactivity emanating from each of the top technologies, a whole range of innovative business models, products, and services will be launched at unprecedented speed in the future. We have come up with over 25 such unique convergence scenarios.

The Top 50 technologies we have selected for TechVision 2015 have the power to drive unique convergence and catalyse wide-scale industry disruptions. Frost and Sullivan's TechVision program empowers you with ideas and strategies to leverage the innovations and disruptive technologies that can drive the transformational growth of your organization.

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