TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

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1. TORSIONAL MICROSCALE MOTOR DEVELOPED USING VANDIUM OXIDE

A large number of electronic device manufacturers are currently working on integrating vanadium oxide material into their products for the various advantages in terms of efficiency and effectiveness that this material possesses. Researchers from the Lawrence Berkeley National Laboratory have demonstrated that the above-mentioned factors can be achieved by using vanadium oxide in a micro-sized robotic torsional muscle or motor.

Researchers from the US Department of Energy (DOE)'s Lawrence Berkeley National Laboratory (Berkeley Lab) have developed a micro-bimorph dual coil using Vanadium Oxide material. This coil has the capability to function as a powerful torsional muscle that can be thermally or electro-thermally achieved by the transition phase obtained vanadium oxide. Employing a simple design and inorganic materials, the researchers have achieved superior performance in power density and speed of the motors and actuators that are used in integrated micro-systems these days. Vanadium oxide is a desirable material in the electronics industry as it has the potential to act as an insulator at very low temperatures and transit into a conductor at a temperature of 67 degrees C. This capability of the material to transit from one phase to another at a particular temperature is seen as a desirable feature to manufacture faster and significantly high energy efficient electronic and optical devices. When the temperature increases rapidly, the crystals present in the material undergo a structural phase change where they contract along one dimension and expand along the other two dimensions. The structural phase transition makes vanadium oxide suitable for use in multifunctional motors and artificial muscles. In order to conduct the experiment, the researchers fabricated a micro muscle on a silicon substrate from a bimorph ribbon, which was V-shaped and composed of chromium and vanadium oxide. By releasing the V-shaped ribbon from the substrate, it was seen to form a helix that consisted of a dual coil connected at both ends to the chromium electrode pads. The dual coils were then actuated by heating which causes a micro explosion; this causes a rapid change in the resistance of micro-muscles and shape, thereby pushing the object away through the proximity sensors that are attached to the micro-muscle. The heating of the micro muscle can either be done by using a small heating pad or by using an electric current that is applied directly to the dual coil. The researchers have also found that it is more efficient and effective to use an electric current for heating since it facilitates the selective heating of the individual micro muscles. It has also been seen that the heating and cooling process takes place at a faster rate while using electric current. According to the researchers, these micro muscles can be assembled into a micro robotic system, which simulates an active neuromuscular system. From the experiments conducted, the researchers were able to demonstrate that the reversible torsional motion over one million cycles without any degradation can be achieved using the micro muscles developed from vanadium oxide. This micro muscle also demonstrated that it had a rotational speed of approximately 2,00,000 rotations per minute (rpm) with an amplitude of 500 to 2000 degrees per millimeters in length and an energy density of approximately 39 kilowatts/kilogram. The above-mentioned values obtained from a micro muscle developed using vanadium oxide have magnitudes higher than the existing torsional motors that are based on electrostatics, magnetics, carbon nanotubes and piezoelectric that are commonly used these days. This project has been supported by the US Department of Energy (DOE) and the researchers are expecting this material to be used in a wide range of application sectors by 2016.

Some of the advantages of using vanadium oxide material are that it increases the efficiency and power density of the products in which it is used; moreover, as this material absorbs light and converts it into heat energy, the coil can also be actuated optothermally.

With the number of advantages that this material possesses, it is expected that a large number of electronics and robotics companies would be using this material in their products in the future.

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2. MANUFACTURE OF FABRIC MATERIAL PRODUCTS USING 3D PRINTERS

Until now, only products based on metals and plastics have been manufactured using the 3D printing process on a large scale. There is a growing need for the adoption of 3D printing technology for fabric-based commercial products.

Researchers from the Human Computer Interaction Institute of Carnegie Melon University (CMU), USA, have developed a novel 3D printer capable of producing products using wool and wool blend yarns into fabric objects that people use on a daily basis. This research by the CMU researchers has been supported by Disney Research, USA. According to the researchers, this innovation would be helpful in extending the range and variety of materials that are available for 3D printing and also would open up newer applications in the years to come. Some of the potential application areas for the employment of this novel printer are apparel manufacturing, accessories, such as scarves, hats, and even toys. This can also be used in the manufacture of soft robots which are designed to be touch or be near humans. Recently, soft robots have been gaining large-scale adoption in the market these days. This printer was showcased at the CHI conference on Human Factors in Computing Systems which was held on the 28th of April, 2014 at Toronto.

This 3D printer is capable of manufacturing objects and products like any other printer that is currently available. The products can be manufactured directly from the Computer Aided Designs (CAD) systems, thereby making it suitable for rapid prototyping and customization of parts and products that are being manufactured. The operation of this novel printer is very similar to the Fused Deposition Modelling (FDM) technique. FDM is one of the most commonly used techniques in 3D printers, which allows the plastic materials to be extruded in a thin line to a layer. Then, these layers are added one above the other to achieve the desired shape of the final product when the layers stick to each other as the materials cool down. In this novel printer, the head of the printer feeds out the yarn instead of lines of melted plastic material that are used in other 3D printers. A needle which is attached to the head of the printer then pierces the yarn thereby bringing down the individual fibers into the yarn in the layers that are already formed. When the individual fibers are made to come in contact with the other layers, the entangling of the fibers and the bonding of the layers takes place.

The researchers have said that the dimensional accuracy of this novel printer is not high compared to the conventional 3D printers since the yarn is much thicker than the layers of plastic which is deposited in FDM printing. They have also said that if these soft objects are to be attached with a hard object, then a layer of nylon mesh fabric should have to be incorporated in the printing process. The nylon mesh would help prevent the material from falling apart at the point of attachment. The researchers are currently working on developing techniques that help in joining soft and hard materials in a single fabrication cycle and also for incorporating electronic components in these soft objects.

This novel 3D printer is expected to be commercialized by 2015. It has the potential to be adopted on a large scale by a wide range of industries for manufacturing various products. It is also seen as a major breakthrough in 3D printing, which is being adopted widely on a large scale around the world.

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3. DEVELOPMENTS IN THE FIELD OF GREEN OR SUSTAINABLE MANUFACTURING

Governments worldwide have laid down policies or regulations for the adoption of green sustainable manufacturing methods in order to protect the environment and people. Currently, there are many approaches that help companies achieve green sustainable manufacturing, but most of these approaches do not take into account all the key aspects that are required for achieving it. Oregon State University, USA has developed a novel approach that would help manufacturing companies to achieve sustainable manufacturing by taking into account all the key aspects.

Engineers from Oregon State University, USA have developed a novel approach for sustainable manufacturing. This novel approach is designed in such a way that it starts from the shop floor of the company. Some of these issues have economic, environmental and social impacts**.** Some of the past methods used finished products or parts that usually did not consider the human and social impacts. The findings of this research have been published in the January 2014 edition of the *Journal of Cleaner Production*. These findings also reflect a part of society's growing demands for manufacturing systems that are focused on protecting both the people and environment while using a manufacturing process that would be viable for the company to make profits on their products. This novel approach has been demonstrated by the researchers in the production of stainless steel knives which was based on an industry project. This novel approach can also be used for any manufacturing system or product. For every decision, this approach considers various aspects such as manufacturing techniques, speed of operations, impact on the environment, materials, energy consumed and the waste that is produced. Decisions can also be made based on compliance with the various laws and regulations in addition to the effects of various approaches on the safety and satisfaction of the workers. This novel approach is one of the very few that consider systematically the social impacts on the workplace environment, thereby ensuring workers are productive and safe. The social impacts are often not considered by the manufacturing companies since they are difficult to measure and quantify but aspects related to the satisfaction and safety of the workers are important aspects. This novel sustainable manufacturing approach incorporates some of the previous concepts of sustainability, such as the life cycle assessment that considers the totality of energy consumed, environmental impacts and other key issues. The lifecycle assessment concept has been found to have proven value in the past. The researchers are currently working by collaborating with Sheldon Manufacturing Inc., of Cornelius, Ore, USA. This company is the designer and manufacturer of equipment that is used in laboratories. Currently, the researchers are focused on developing this manufacturing approach to be implemented for various levels of manufacturing. This project has been funded and supported by Benchmade Knife Co., Sheldon Manufacturing, and the Oregon Metals Initiative, USA. This approach is expected to be adopted on a large scale by companies by 2016.

The advantage of this novel approach is that it allows companies to achieve sustainable manufacturing. Due to the above-mentioned advantage and also the various proven aspects that the researchers have incorporated in this approach, it has the potential to be adopted on a large scale by manufacturing industries in the years to come.

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4. PATENT ANALYSIS OF LASER-ENGINEERED NET SHAPING PROCESS

The principle behind the working of the laser engineered net shaping (LENS) process is that a laser is employed to selectively clad the metallic powder. In this process, a molten weld pool is created from a metal substrate by using a high-powered laser which is usually greater than 300 watts. The metallic powder is then transferred into the weld pool by using an inert gas, which is then melted in the pool. As the laser passes by the deposit, it is cooled, thereby creating a thin line metal. The substrate is then moved relative to the beam in order to deposit the thin metallic lines with a finite width and thickness. As the laser focusing lens and powder delivery nozzle are raised along the z-axis, successive cross sectional layers are added to form the final metal product. Once the final part is completed, the substrate is removed by machining or by dissolving in chemicals.

From the patents that have been exhibited, it can be seen that the research is being carried out to improve the assembly of the LENS system and also the range of materials that could be used in this process. Alstom Technology Ltd. and Siemens Energy Inc. are seen to be the key patent applicants for this technology.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Double lens laser welding assembly	April 27, 2013/ CN 203265908 U	Dalian Hongik Precision Parts Manufacturing Co., Ltd.	Lin Bo , Sun Haijun , Jia-Ming Zhang	The utility model is a dual-lens laser welded components, including single-focus lens A (3), single-focus lens B (8) and lens mounting plate (2), characterized in that the fixed plate (2) on the bracket with a lens A (1) install a single-focus lens A (3), with a lens holder B (7) mounted a single-focus lens B (8), two single-angle zoom lens for α; lens mount plate (2) above install a flat position to traverse device (13); lens mount plate (2) below the middle of the lens bracket (9) fixed connection, the lens bracket (9) and the pressure cam (11) is connected, press the cam (11) mounted at the left end of the platen (10); pressure cam (11) provided below the turntable (4), a turntable (4) mounted to a right end of the stopper (12), a turntable (4) provided below the indexer (5), Indexer (5) in the middle with output shaft (6). The utility model to solve the technical problems of pure aluminum welding equipment, welding points will get double the energy to make it easier to induce the formation of the initial welding, greatly improving the reliability and stability of welding, improved product quality.
Silver-based alloy powder for manufacturing of 3-dimensional metal objects	March 1, 2013/ WO 2013128416 A2	Legor Group S.P.A.	Andrea Basso, Massimo Poliero	The invention relates to a silver-based alloy powder comprising from 70% to 99.99 wt% of silver and from 0.01% to 5 wt% of at least one element chosen from germanium (Ge), aluminium (Al), silicon (Si) and boron (B), or a mixture thereof. The powder is used in a method of direct manufacturing or prototyping (for example, selective laser melting, selective laser sintering, or Electron Beam Melting) for the manufacturing of 3 -dimensional metal objects such as a piece of jewellery, a component for the watch, spectacle or pen industry; a component for the accessory industry; an object or part of an object of art; a component for the medical industry; or a component for the high-tech industries.

Wear resistant low friction coefficient surfaces for joint and bone replacement materials and devices	February 11, 2013/ WO 2013122862 A1	Washington State University	Susmita Bose, Amit Bandyopadhyay	A metal matrix has a biocompatible solid lubricant in at least a portion of its surface and the solid lubricant functions to protect the interior of the metal matrix and minimize the friction coefficient and related wear induced damage at the articulating surface of the metal device. The lubricated biocompatible metal device is made of materials compatible for in vivo and ex vivo applications in order to minimize wear induced degradation as well as metal ion release. The lubricated biocompatible metal device is suited for use as medical implants.
Method for additively manufacturing an article made of a difficult-to-weld material	December 6, 2012/ WO 2013087515 A1	Alstom Technology Ltd	Lukas Emanuel Rickenbacher,Alexander Stankowski, Simone Hoevel, Thomas Etter	The invention relates to a method for additively manufacturing an article (10) made of a difficult-to-weld highly-precipitation-strengthened Ni-base super alloy that comprises Al and Ti in the sum of more than 5 wt. -% or a difficult-to weld carbide/solution-strengthened cobalt (Co)-base super alloy, whereby a metal particle mixture (14) of at least a first phase (11) and a second phase (12) is provided as a starting material, said first phase of the mixture being a base material and said second phase of the mixture being a material which is a derivative of the first material and has relative to said material of said first phase an improved weldability, and whereby the metal particle mixture (14) is processed by means of an additive manufacturing process which is one of selective laser melting (SLM), selective laser sintering (SLS), electron beam melting (EBM), laser metal forming (LMF), laser engineered net shape (LENS), or direct metal deposition (DMD).
Methods for fabricating gradient alloy articles with multi-functional properties	October 30, 2012/ WO 2013112217 A2	California Institute Of Technology	Douglas C. Hofmann, John Paul C. BORGONIA, Robert P. DILLON, Eric J. SUH, Jerry L. MULDER, Paul B. GARDNER	Systems and methods for fabricating multi-functional articles comprised of additively formed gradient materials are provided. The fabrication of multi-functional articles using the additive deposition of gradient alloys represents a paradigm shift from the traditional way that metal alloys and metal/metal alloy parts are fabricated. Since a gradient alloy that transitions from one metal to a different metal cannot be fabricated through any conventional metallurgy techniques, the technique presents many applications. Moreover, the embodiments described identify a broad range of properties and applications.

Laser with beam transformation lens	November 9, 2011/ EP 2591875 A1	Leister Technologies AG	Ulrich Gubler, Daniel Vogler, Thomas Didden	The system (1) comprises a laser beam source (6) for generating a laser beam (7) having a non-uniform beam profile, and a laser lens system (2) for forming laser beam and for projecting the laser beam onto the workpieces (5), arranged in the radiation direction of laser beam source. A laser mask is arranged close to the workpieces, between the laser optical system and the workpieces. The lens system comprises a beam transfofrmation lens (3) to homogenize the beam profile, and an optical element (4) for collimating the laser beam, arranged in the radiation direction of lens.
Method of manufacturing a component by hot isostatic pressing	July 25, 2011/ EP 2551040 A1	EADS Deutschland GmbH, EADS UK Ltd.	Achim Schoberth, Frank Palm, Dr. Erhard Brandl, Jonathan Meyer, Chris Turner, Andrew Hawkins	In a method for manufacturing a homogenous near net-shape component made of a material selected from a metal, a metal alloy, or a metal matrix composite, with the proviso that said the material does not decompose or otherwise undergo a quick chemical reaction before or during it melts or before or during the metal or metal alloy in the metal matrix composite melts, a gas tight container having one or more cavities and one or more walls is formed of said material by additive layer manufacturing (ALM) such that the container contains said material in comminuted form, whereafter the container and its content consisting of the same material is subjected to hot isostatic pressing. A system based on electron beam ALM consisting of a gas tight container without any welding seem and a communited material of the same kind from which the container is formed in the cavity or cavities thereof is also disclosed.
Personal fit medical implants and orthopedic surgical instruments and methods for making	April 15, 2010/ WO 2010120990 A1	James Schroeder	James Schroeder	The present invention provides methods, devices, systems, and instruments related to medical implants and surgical instruments produced to precisely fit individual subjects. In particular, the present invention utilizes a combination of medical imaging, quantitative image analysis, CAD, CAM, and additive manufacturing processes to personalized biocompatible devices.

Laser based metal deposition (lbmd) of antimicrobials to implant surfaces	June 7, 2007/ WO 2008002750 A3	David William Britt, Durga Janaki Ram Gabbita, Daniel F Justin, Medicinelodge Inc, Brent E Stucker	David William Britt, Durga Janaki Ram Gabbita, Daniel F Justin, Brent E Stucker	A method is provided for depositing a hard wear resistant surface onto a porous or non-porous base material of a medical implant. The wear resistant surface of the medical implant device may be formed by a Laser Based Metal Deposition (LBMD) method such as Laser Engineered Net Shaping (LENS). The wear resistant surface may include a blend of multiple different biocompatible materials. Further, functionally graded layers of biocompatible materials may be used to form the wear resistant surface. Usage of a porous material for the base may promote bone ingrowth to allow the implant to fuse strongly with the bone of a host patient. The hard wear resistant surface provides device longevity, particularly when applied to bearing surfaces such as artificial joint bearing surfaces or a dental implant bearing surfaces. An antimicrobial material such as silver may be deposited in combination with a metal to form an antimicrobial surface deposit.
Rapid prototyping of ceramic articles	July 6, 2006/ US 8575513 B2	Siemens Energy, Inc.	Zafir A. Abdo, Ahmed Kamel	A method for forming ceramic articles for prototypes that involves the use of metal particles or metal-coated ceramic particles that are formed into ceramic articles using a laser engineered net shaping process. The metal particles or metal coating on the ceramic particles facilitates bonding between the ceramic particles to enable quick manufacture of ceramic articles using the laser engineered net shaping process. The ceramic articles may be ceramic core prototypes and may be used in a variety of different industries.

Exhibit 1 depicts patents for laser engineered net shaping process.

Picture Credit: Frost & Sullivan

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