TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

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1. ADDITIVE MANUFACTURING TECHNIQUE WITH INCREASED PRECISION

Three-dimensional (3D) printing or additive manufacturing has been garnering significantly high interest and use from a wide range of industrial sectors around the globe, with various universities and research organizations carrying out research activities to make the technology more viable for different industrial sectors, such as automotive, aerospace, healthcare, consumer products.

A group of researchers from the US Department of Energy's Oak Ridge National Laboratory, USA has developed an additive manufacturing method that is capable of controlling the structure and properties of metal components with precision that is not achievable by using the conventional manufacturing processes. This novel method is capable of controlling the local material properties of the metal which in turn would help in changing the way metallic components are engineered for different components in various industrial sectors. The manufacturing method developed by the researchers is expected to make parts that are stronger, lighter, and more energy efficient that will be well suited for applications, such as automobiles and wind turbines. The researchers have demonstrated the method using an electron beam melting system (EBM) where successive layers of metal powders were fused together into a three-dimensional product using an electron beam. The researchers have managed metal solidification with high precision on a microscopic scale through 3-dimensional control of the microstructure or crystallographic texture of a nickel part during formation. It has been seen that the crystallographic texture of a part plays a key role in the determination of the physical and mechanical properties of a material. For instance, application sectors such as microelectronics and high-temperature jet engine components have significantly high dependence in the crystallographic texture of the materials in order to achieve the desired characteristics in terms of performance and reliability. The researchers believe that this method of additive manufacturing

would be useful in the manufacturing sector for the production of parts with significantly high levels of detail. The innovation would help them in specifying the location of specific orientations of a crystal structure in a part. This research has been funded by the Advanced Manufacturing Office in the Department of Energy's office of Energy and Efficiency and Renewable Energy.

Some of the advantages of this novel method are that it increases the range of materials that could be used for manufacturing parts with high efficiency and durability. Moreover, this method could be adopted by industries manufacturing parts with high detail for their applications. With all the above-mentioned capabilities and advantages, in addition to the growing need for novel additive manufacturing techniques in the market, this new method has significant potential to be adopted on a significant scale once it is commercialized.

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2. LOW-COST ROBOTIC SWARMS FOR RESEARCH ACTIVITIES

Robotic swarms that are developed based on inspiration from biological organisms are currently witnessing widespread interest among various research organizations around the globe working on developing novel robotic swarms. Some of the challenges faced with the development of robotic swarms are the complexities with the hardware and the costs associated with the creation of hardware platforms.

Researchers from the University of Lincoln, UK, in collaboration with Tsinghua University in China have developed a novel swarm robot that can be deployed for various applications. The swarm robot, named Colias, is capable of working in an autonomous platform. The robot extremely small and fast, making it suitable for fast-paced swarm scenarios over large areas. According to the researchers, the working platform used in the robot is low cost when compared to the traditional robotic platforms that are currently available. This makes the robot more suitable and economical for researchers around the globe. The researchers have said that the robot has been designed as a complete platform with supporting software development tools to perform tasks for robotics education and research. The innovative concept used in the robot allows for to coordinating simple robots to

cooperatively perform tasks. The decentralized control of robots is said to be achieved by giving well-defined interaction protocols for each of the individual robots in the swarm. Colias is developed in a bio-inspired environment, thereby making it extremely responsive to collective behavioral patterns, which is vital for swarm robots. The aim of imitating the bio-inspired mechanism of swarm robots was to enable all research groups across the globe, including those with limited funding, to carry out research using real robots. The robot has been equipped with two long-range infrared proximity sensors that allow it to communicate with its direct neighboring robots that are in a range of 0.5 centimeters to 2 meters. In addition to the long range sensors, there is also an independent processor the allows the individual robots in the swarm to detect obstacles. The researchers are currently working on expanding the capabilities of the robot by extending a vision module with the help of a computer processor that enables vision mechanisms.

Some of the advantages of this novel robot is its significantly small size, high processing speed, and low cost. The low cost of these robots can allow research organizations and universities to adopt them on a large scale. With all the above-mentioned capabilities and advantages, this robot has the potential to be significantly adopted once it is commercially available.

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3. ALGORITHM FOR INCREASING EFFICIENCY OF HOUSEHOLD ROBOTS

The use or development of robots for household activities has been increasing at a rapid pace in the recent past. A number of these robots are being developed around the globe for various applications. One of the key capabilities is the recognition of various objects in the surroundings. A drawback seen with most of the robots available currently is that they may fail to recognize objects. Researchers are trying to address this challenge by making robots more mobile and their recognition more precise by imaging the objects from different perspectives before the robots make a decision about the identity of the object.

Researchers from the Massachusetts Institute of Technology (MIT), USA have developed a novel algorithm for increasing the vision capabilities of robots that used for household activities. The researchers have developed this novel

algorithm to increase the recognition performance of the robots in addition to significantly reducing the number of misidentifications. Besides being highly precise, this algorithm is said to be 10 times faster than the algorithms that are currently available in the market, thereby making it more practical for real-time utilization for household robots. In order to make this novel algorithm more efficient, the researchers have adopted an approach by which the algorithm does not discard any of the assumptions it comes across through the images that it captures. Moreover, it does not evaluate each of the assumptions individually; instead, it does the sampling at random. The number of samples that the robot analyses has been kept low by the simplified technique used in this novel algorithm. For instance, if the robot using this algorithm identifies three objects from one perspective and another three from another perspective, the robot then finds the most efficient way to compare and match the common objects from the two sets. By carefully analyzing the objects, the possibility of error by the robot in identifying the object and selecting the object is reduced significantly. Also, this task is done at a faster rate.

Some of the advantages of this novel algorithm for household robots are that they increase the efficiency with which the robots carry out various tasks and significantly reduce the number of errors that might occur. Due to the above-mentioned capabilities and advantages this algorithm has opportunities to be adopted for a household robots, which are poised to witness increased adoption in the coming years.

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4. PATENT ANALYSIS OF ULTRASONIC ADDITIVE MANUFACTURING PROCESS

Ultrasonic additive manufacturing is also known as ultrasonic consolidation. This process is based on employing a delicate welding process for joining strips of metal parts together, thereby manufacturing a part containing one sheet of a metal. Ultrasonic additive manufacturing bonds the metal strips together using the ultrasonic welding process, which involves solid state welding where a bond is created without the metal being melted. The low temperature used in the

ultrasonic welding process eliminates the brittleness that occurs in the layers of metals that are caused with other welding processes. This method also allows the metallic bonds to be formed between different metals.

One of the latest patents in ultrasonic additive manufacturing, US 8581472 B2, is assigned to Nihon Dempa Kogyo Co. Ltd. It pertains to an Ultrasonic probe and manufacturing method that includes manufacturing of an ultrasonic probe that has a copper signal foil patterned by an additive method. Some of the other key innovators for this manufacturing process include Board of Regents, the University of Texas System (US 2013103600 A1), which pertains to an extrusion-based additive manufacturing system for 3D structural electronic, electromagnetic, and electromechanical components or devices; and Edison Welding Institute Inc. (EP 2544880 A1), which pertains to an ultrasonic welding assembly or system to enhance sonotrode performance in ultrasonic additive manufacturing.

Title	Publication Date/ Publication Number	Assignee	Inventor	Abstract
Ultrasonic probe and manufacturing method thereof	November 12, 2013/ US 8581472 B2	Nihon Dempa Kogyo Co., Ltd.	Yasunobu Hasegawa	A manufacturing method of an ultrasonic probe that has a signal foil made of a copper foil patterned by an additive method is provided. The manufacturing method includes preparing a base material and forming an insulating layer on a surface of the material, patterning the insulating layer by exposure, development, and peeling according to a lithographic technique, forming a cavity reaching an upper surface of the base material in the insulating layer along the patterning, forming a signal foil by performing plating in the cavity in the order of copper plating and solder plating, and demolding the formed signal foil from the cavity.

Extrusion-based additive manufacturing system for 3d structural electronic, electromagnetic and electromechanical components/ devices	July 11, 2013/ WO 2013103600 A1	Board Of Regents, The University Of Texas System	Ryan B. Wicker, Eric Macdonald, Francisco Medina, David ESPALIN, Danny W. MUSE	The present invention provides a system and method for making a three-dimensional electronic, electromagnetic or electromechanical component/device by: (1) creating one or more layers of a three-dimensional substrate by depositing a substrate material in a layer-by- layer fashion, wherein the substrate includes a plurality of interconnection cavities and component cavities; (2) filling the interconnection cavities with a conductive material; and (3) placing one or more components in the component cavities.
Torsion sonotrode, ultrasonic welding device and method for producing a welded connection by means of ultrasonic sound	March 28, 2013/ US 20130075454 A1	Telsonic Holding Ag	Albert Buettiker	The invention relates to a torsion sonotrode, comprising two mutually opposing end faces (S1, S2) and a circumferential surface (U) which surrounds a torsion axis (T) and on which at least one working surface (A1, A2, A3, A4) is provided at a radial distance from the torsion axis (T).
System for enhancing sonotrode performance in ultrasonic additive manufacturing applications	January 16, 2013/ EP 2544880 A1	Edison Welding Institute, INC.	Matthew A. Short	An ultrasonic welding assembly, comprising: a sonotrode having a single welding region and two nodal regions formed on either side of the welding region; a mounting plate for supporting the sonotrode having a force application region on the upper surface thereof; at least one ultrasonic transducer connected to the sonotrode; at least one diaphragm spring disposed between the ultrasonic transducer and the sonotrode; at least one roller bearing connected to the diaphragm spring; at least two linear guides connected to the roller bearing, wherein the at least two linear guides are connected to the mounting plate and support the roller bearing and the sonotrode in a flexible manner; and first and second low-friction linear bearings in contact with nodal regions for the

				application of downward force to the sonotrode, wherein the first and second linear bearings are connected to the mounting plate.
Method for producing a watch case middle of reduced weight	August 8, 2012/ EP 2485099 A2	Richemont International S.A.	Laurent Cataldo, Greg M. Morris, Eli Liechty	A method for producing a watch case middle (10) having reduced weight is disclosed. A 3-D data set is generated for the case middle, the model comprising at least one internal cavity (50) within the case middle. The 3-D data set is converted into a plurality of layers, each layer representing a cross-sectional layer of the middle, and then the case middle is formed layer-by-layer from powdered material using an additive manufacturing process such as DMLS in order to provide the case middle with a unitary construction. Loose powder is removed from each cavity via one or more powder evacuation holes (60,62) formed between the cavity and an external surface of the case middle, and a through hole (40,42) formed through the middle is machined to a desired finish and/or precision, the through hole being designed to receive a control member stem when a watch movement is mounted inside the middle.
Methods for fabricating gradient alloy articles with multi-functional properties	October 30, 2012/ WO 2013112217 A2	California Institute Of Technology	Douglas C. Hofmann	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.

Methods for fabricating gradient alloy articles with multi-functional properties	October 30, 2012/ WO 2013112217 A2	California Institute Of Technology	BORGONIA, Robert P. DILLON, Eric J. SUH, Jerry L. MULDER, Paul B. GARDNER,	A method of fabricating a multi-functional multilayer article comprising: determining a shape for the article and defining at least two spatially separated regions on said article, said two regions to be formed of at least two distinct materials being joined by at least one compositional gradient transition region;
Ultrasonically-assisted extrusion methods for manufacturing powdered nutritional products	December 22, 2011/ Abbott Laboratories	Abbott Laboratories	Terrence B Mazer, Gary M Gordon, Rima Tabash	Disclosed are methods of manufacturing powdered nutritional products, including powdered infant formulas and powdered adult nutritional products, using extrusion. The methods include utilizing ultrasonic energy in the extruder during manufacturing. The application of ultrasonic energy to the extruder allows the fat globules present in raw materials to be effectively emulsified by hydrated protein present in the feed stream such that the resulting powdered extruded product has a low free fat level, is less susceptible to oxidation and rancidity, and can be reconstituted without substantial fat separation.
Surface roughness reduction for improving bonding in ultrasonic consolidation rapid manufacturing	May 24, 2007/ US 20070295440 A1	Stucker Brent E, Gabbita Durga J R	Brent Stucker, Durga Gabbita	A method for enhancing the bonding and linear weld density along the interface of material layers deposited in accordance with an ultrasonic consolidation manufacturing process, the method comprising: initiating an ultrasonic consolidation manufacturing process; depositing a first material layer having a contact surface; reducing surface roughness of the contact surface to prepare the contact surface to receive a subsequent material layer, the step of reducing facilitating an increased percentage and quality of material contact between the first and subsequent material layers; and bonding a subsequent material layer to the contact surface of the first material layer, as prepared.
Ultrasonic object consolidation system and method	October 8, 2002/ US 6463349 B2	Solidica, Inc.	Dawn White, David E.E. Carmein	Machine tools combine material addition via ultrasonic object consolidation and subtractive techniques for imparting high-dimensional accuracy to a finished object. A material supply and feeder, ultrasonic horn, and feedstock cutting

				device are integrated with a material removal subsystem preferably including a cutting tool and an excess material removal system. Any metal, plastic or composite material suitable for ultrasonic joining may be employed as a feedstock, and these material may assume the form of tapes, sheets, wires, filaments, dots or droplets, with the feeding and material cutting components being designed for the specific feedstock employed. The cutting tool for excess material removal, may be a knife, drill/mill, grinding tool, or other tool capable of accurately cutting the external contour of a cross section of the part being built, and for removing excess feedstock remaining following the application process. The material removal could consist of a vacuum or blower system, chip auger, or other suitable apparatus. A machine disclosed as part of the preferred embodiment is able to deposit material in one step, and optionally and selectively remove it in another. Through the expeditious combination of deposition and removal, the fabrication of objects of arbitrary shape may be realized.

Exhibit 1 depicts patents related to the ultrasonic additive manufacturing process.

Picture Credit: Frost & Sullivan

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