TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

05th June 2015

1. MACHINE TOOL TO INCREASE PRODUCTION EFFICIENCY IN THE AUTOMOTIVE SECTOR

With the development and production of a wide range of automotive models, manufacturing companies are in need of newer techniques and devices that can enable use of the same production systems for manufacture of different models, without having to stop the production process. Researchers from the Fraunhofer Institute of Machine Tools and Forming Technology IWU, Chemnitz, Germany developed a device that addresses the above-mentioned challenge without consuming much time and cost.

The researchers engineered a novel device that is capable of directly transferring the pre-determined parameters for serial production. This device is expected to reduce the start time of any manufacturing process in the plant by almost 50%. The "try-out" technique used in this device has been applied in reshaping processes at the pressing plant. The presses employing the try-out technique determine the regulating variables for quality production beyond the serial processes that are currently being used on a large scale in the market, without an interruption to the production process. The presses are capable of simulating the process parameters and the production environment of the regular system. With the new device, researchers have been able to transfer the try-out process to the clamping devices that are used in the assembly of a car body. The device contains four functional elements whose assembly is similar to that of a construction kit. The height module in this device is used for flexibly adjusting the height of the console and the angle module is for determining the clamping elements angle. By using the modulus of rigidity, the researchers have been able to determine the rigidity of the clamping device in the case of it being made using materials such as steel, aluminum or any other synthetic material.

According to the researchers, the systems based on the try-out process can be used for devices required by automotive manufacturers to produce various parts used in their cars. The researchers have conducted a few experiments on the device and were able to simulate the rigidity of the individual components and the clamping elements. In the experiments, they have also tested the limits of the system and have tried determining the weight that could be saved without having to compromise on the stability of the construction. However, with this device, such a change is not necessary, making it significantly easy for the manufacturers to have a flexible production system in their plants. The researchers have now completed the development of this novel device and are currently looking for industry participants to adopt this device into their manufacturing plants.

The advantage of this device is that it reduces the time taken for assembly and production of new parts, thereby resulting in increased production efficiency and lower cost for the manufacturers. The device has potential to be adopted by automotive manufacturers.

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2. PRODUCTION PROCESS FOR REDUCING THE TIME OF CHANGE IN SHAPE MEMORY ALLOYS

Currently, shape memory alloys are being employed in various parts—such as actuators, and switches—used in aerospace, automotive, and industrial sectors, among others. Research efforts to reduce the time required for achieving stabilization in the shape memory alloys are ongoing.

Researchers from the NASA Glen Research Center, USA, have developed a novel thermo-mechanical methodology for stabilizing the shape memory alloy response. This innovative development has the potential to reduce the time required for stabilizing the strain temperature response of a shape memory alloy (SMA).

The conventional process for stabilizing the SMAs would take a few days or weeks to achieve the required stabilization, but with this novel method, the stabilization could be achieved in a few minutes. Bringing down the stabilization time to minutes would make it more useful for industries to adopt SMAs for their applications. This innovation could also be applied for components having complex geometries and not just simpler components such as wire and rods. The process of stabilizing SMA for an actuator response is usually carried out for stabilizing the strain during the thermal cycle under fixed stress. Stabilization of the strain is usually governed by the internal states that are produced by the combination of stress and temperature. Any combination of stress and temperature could be employed for obtaining the strain section that can be used for the stabilization of the alloys. The conventional processes employ this principle of thermal cycling under fixed stress to achieve the stabilized behavior, but this process takes a significantly large amount of time and is also expensive.

In the innovative process developed by the researchers, the stabilization is carried out using mechanical cycles under fixed temperature conditions. By doing so, the time taken has been significantly reduced since the time taken for mechanical cycling is much less when compared to thermal cycling. In the experiments conducted to test this novel process, the stabilization point of the material was achieved by carrying out an isobaric experiment under the conditions that were similar to the industry conditions. When the stabilization point was reached, a set of isothermal mechanical cycling experiments were conducted using various levels of applied stress. Once the stress levels required for achieving the stabilization under isothermal conditions are known, they could be used for any number of parts using the same material in significantly less amount of time. From this experiment, it was found that when the strain state is achieved isothermally, it could also be changed back to the original state under the isobaric conditions. This would make it possible to keep the materials stabilized for a longer time. The researchers are working on filing a patent for this novel process.

Some of the advantages of this process are that it reduces the time required for achieving the stabilization. The time reduction achieved significantly increases production efficiency, thereby increasing SMA’s applications in various sectors. This process has the potential to be significantly adopted after commercialization because of its potentially large benefits.

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3. MANUFACTURING PROCESS TO INCREASE STRENGTH OF CARBON NANOFIBERS FOR INDUSTRIAL PURPOSES

Composite materials are used in a wide range of applications such as airplanes, automobiles, bicycle parts. Researchers around the world have been working on improving the strength of composite materials such as carbon nanofibers. A group of researchers from the University of Nebraska-Lincoln has developed an innovative process to improve the quality and strength of the carbon nanofibers.

Researchers from the department of mechanical and materials engineering of the University of Nebraska-Lincoln, USA, have discovered that use of a significantly small amount of graphene oxide as a template can improve carbon nanomaterial, which in turn improves composite materials. Graphene is one atom thick layer of carbon with a crystalline structure. This makes it exceptionally strong and gives it significantly high heat and electrical conductivity. The researchers from the University of Nebraska-Lincoln have collaborated with a group of researchers from the Northwestern University and Materials and Electrochemical Research Corp. of Tucson, Ariz., USA, for this endeavour. A novel process has been developed by the researchers to incorporate the graphene oxide nanomaterials as a template that would guide the formation and orientation of continuous carbon nanofibers. This improves the properties of the fiber.

In this process, graphene is crushed, similar to a sheet of paper, in a manner that improves it as a templating and orientation agent. The process requires only a small amount of graphene particles unlike conventional processes in which large amounts of graphene particles are added to the fibers. Rather, the researchers have followed the process of graphene-addition with the carbonization process, developing a structure for the carbon nanofiber that is similar in orientation to fibers with enhanced strength and improved material properties. Currently, these graphene-based nanofibers are being tested for their strength; the researchers are also working on improving the technique for producing nanofibers. The graphene-based nanofibers have the potential to significantly reduce the cost of manufacturing composites since a small quantity of the expensive nanoparticles are used and the process developed by the researchers is also said to be inexpensive.

The findings from this research have been published in the December 10th, 2013, issue of *Advanced Functional Materials* journal. The funding for this research was received from grants from the US Army Research Office's Multidisciplinary University Research Initiative, the Air Force Office of Scientific Research, and the National Science Foundation. The researchers are currently working on filing a patent for the process.

Some of the advantages of this novel process are that it reduces the cost associated with developing graphene-based carbon nanofibers and also increases the strength of the material that is obtained. With such advantages, the process has potential to produce high performance and low-cost nanofibers for a range of industries an dapplications.

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4. PATENT ANALYSIS OF FUSED DEPOSITION MODELING

Fused deposition modeling (FDM) is a type of three-dimensional (3D) printing technique that employs two kinds of materials—a material for modeling that forms the finished product, and a support material that is used as scaffolding for supporting the product being printed. During the printing process, the materials are in the form of plastic threads or filaments that are unwound from a coil and fed into the printer through an extrusion nozzle. The filaments or threads are melted in the nozzle before being extruded onto a base, known as the build platform. A computer program converts the dimensions of the desired object into X, Y and Z coordinates that the nozzle and the base should follow for the printing. The extrusion nozzle in a typical FDM system is made to move over the build platform in both horizontal and vertical directions, thereby etching a cross section of the object to be printed on the platform. The thin layer of filament is then allowed to cool and become hard so that it can be made to bind onto the layer beneath it. Once the layer is completed, the base is slightly lowered, which creates the space required for depositing the next layer of plastic.

This process is employed in a wide range of industries such as automotive, aerospace, consumer goods, healthcare. Industries use this process in their product development, prototyping, as well as manufacturing applications. The key advantages of this process are that products can be manufactured at a relatively fast, with high accuracy and durability.

From the patents exhibited, it can be seen that the research is being carried out for developing innovative parts that can be used in the FDM system to make it more efficient and in using FDM to produce innovative parts. For example, Patent DE 102011075544 A1, assigned to Evonik Röhm Gmbh, pertains to a fused deposition modeling method for producing multi-colored three-dimensional objects with a particularly good color image.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Multicoloured fused deposition modelling print	April 3, 2012/ WO 2012152511 A1	Evonik Röhm Gmbh	Kris BEKS, Sonja CREMER, Ludo Dewaelheyns, Benjamin HAMMANN, Stephan Kohlstruk, Dirk Poppe, Markus PRIDÖHL, Günter Schmitt	A fused deposition modelling method for producing multicoloured three-dimensional objects, in particular a 3D printing method with which 3D objects can be produced with a particularly good colour image in comparison with the prior art. The method is based on the concept that the polymer strand (2) that is used for producing the actual object is coloured in the nozzle (1), and that a mixing device is used for this, comprising one or more injection needles, a static mixer or a dynamic mixer.
Print head assembly for use in fused deposition modeling system	December 21, 2011/ WO 2012088253 A1	Stratasys, Inc.	J. Samuel Batchelder, Timothy A. Hjelsand, Kevin C. Johnson, William J. Swanson	A print head assembly (43) that includes a print head carriage (18) and multiple, replaceable print heads (36, 42) that are configured to be removably retained in receptacles (46, 48) of the print head carriage (18).
Process and apparatus for fabrication of three-dimensional objects	October 26, 2011 / EP 2632696 A2	Eugene Giller	Eugene Giller	A fabrication process and apparatus for producing three-dimensional objects by depositing a first polymer layer, printing a first ink layer on to the first polymer layer, depositing a second polymer layer on to the first ink layer, and printing a second ink layer on to the second polymer layer. The deposition and printing steps may be repeated until a three-dimensional object is formed. The inks used to form at least one of the first and second ink layers may include dyes or pigments so that the three-dimensional object may be a colored three-dimensional object.
Multicolored Fused Deposition Modeling pressure	May 10, 2011/ WO 2012152511 A1	Evonik Röhm Gmbh	Kris BEKS, Sonja CREMER, Ludo Dewaelheyns, Benjamin HAMMANN	A fused deposition modelling method for producing multicoloured three-dimensional objects, in particular a 3D printing method with which 3D objects can be produced with a particularly good colour image in comparison with the prior art. The method is based on the concept that the polymer strand (2) that is used for producing the actual object is coloured in the nozzle (1), and that a mixing device is used for this, comprising one or more injection needles, a static mixer or a dynamic mixer.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Multicolored Fused Deposition Modeling pressure	April 20, 2011/ DE 102011075544 A1	Evonik Röhm Gmbh	wird später genannt werden Erfinder	The invention relates to a modified fused deposition modeling method for the production of multi-colored three-dimensional objects. In particular, the invention relates to a 3D printing process with respect to the prior art 3D-objects can be manufactured with particularly good color image. The inventive method is based on the polymer strand used in the manufacture of the actual object is dyed in the nozzle, and that this a mixing device in which it is a plurality of needles, a static mixer or a dynamic mixer is used.
Print head for use in fused deposition modeling system	December 22, 2010/ US 8465111 B2	Stratasys, Inc.	William J. Swanson, J. Samuel Batchelder, Kevin C. Johnson, Timothy A. Hjelsand	A print head for use in a fused deposition modeling system, the print head includes a cartridge assembly and a liquefier pump assembly retained by the cartridge assembly.
Smoothing method for layered deposition modeling	April 4, 2003/ CA 2482848 C	Stratasys, Inc., William R. Priedeman, Jr., David Thomas Smith	William R. Priedeman, Jr., David Thomas Smith	Disclosed is a method for smoothing the surface of an object built from a polymeric or wax material using a layered manufacturing rapid prototyping technique. After the object is built it is exposed to a vaporized solvent such as in a vaporizer for an exposure time sufficient to reflow the object surface. A solvent is chosen based on its ability to transiently soften the material which forms the object, and thereafter evaporate off the object. The object is removed from the solvent and allowed to dry, producing a smooth finished part.
Method and apparatus for data manipulation and system control in a selective deposition modeling system	September 27, 1996/ WO 1997011835 A3	3D Systems Inc	Jocelyn M Earl, Thomas A Kerekes, Chris R Manners, Paul H Marygold, Jeffrey S Thayer	A variety of support structures and build styles for use in Rapid Prototyping and Manufacturing systems are described wherein particular emphasis is given to Thermal Stereolithography, Fused Deposition Modeling, and Selective Deposition Modeling systems, and wherein a 3D modeling system is presented which uses multijet dispensing and a single material for both object and support formation.

Exhibit 1 depicts patents related to fused deposition modeling.

Picture Credit: Frost & Sullivan

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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