TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

15th August 2014

1. SIMULATION MODEL FOR ASSESSING LOAD BEARING CAPACITY OF RIVETS USED IN AUTOMOBILES

Materials such as steel, aluminum, magnesium, fiber-reinforced plastics are used for manufacturing various parts that are used in automobiles. Welding is a manufacturing technology that is widely adopted by the manufacturers to join parts that are entirely made of steel. For parts that are made using a combination of materials, where welding cannot be employed, mechanical connections such as rivets are employed. Rivets play a major role in holding the chassis of an automobile together reliably even in the case of a crash. Currently, it is difficult to predict the precise load that a rivet would be able to withstand. In many cases, connections are the weak points. For instance, during the event of a crash, the rivets are subjected to failure first; and since a car has about 3000 to 5000 joints, manufacturers around the globe look to minimizing the risk. Simulations are among the techniques that are widely used for verifying the various connection points that could sustain the stresses in a crash. The calculations obtained from the simulations predict the performance of individual joining points, but not for every type of strain. If the components that are joined become bent, then the calculations are not precise. For instance, the computations attribute to greater load capacity than the actual load bearing capacity of the rivet under real conditions. The above mentioned factor is something that the automotive manufacturers are striving to eliminate. Researchers have now developed a novel advanced model, which is capable of delivering more realistic projections.

A group of researchers from the Fraunhofer Institute for Mechanics of Materials (IWM) in collaboration with researchers from Laboratory for Material and Joining Technology (LWF) at Fraunhofer IWM, and from the Association for the Advancement of Applied Computer Science GFaI, Germany, have developed an innovative simulation model for precisely assessing the load bearing capacity of rivets that are being used in automobiles. With this new simulation model, the researchers believe that it would be possible for manufacturers to forecast more reliably both slow and fast bending loads in addition to the pull and shear forces that emerge when the joined components are shifted relative to each other. For testing the newly developed simulation model, sample components were produced from a variety of materials and were connected by rivets to which stresses were then applied. The components were then bent in different directions and were also pulled and pushed at varying speeds. The performance of the rivets was then integrated into mathematical equations containing different parameters such as material properties and densities. The researchers have set to study about 15 different combinations of materials; and based on the data obtained, the projections for other similar materials and density combinations were obtained. From all the data gathered from these tests, it is seen that the new simulation model is accurate and precise.

The advantage of this simulation model is that, it is precise and accurate when compared to the other simulations models that are currently available in the market. Also, it takes into account various stresses that would be acting on the parts that are joined by rivets, thereby making it possible for manufacturers to produce rivet joints that would make automobiles more safer.

Details: Silke Sommer, Researcher, Fraunhofer Institute for Mechanics of Materials IWM, Wöhlerstr, 11, 79108, Freiburg, Germany. Phone: +49-761-5142-266. E-mail: silke.sommer@iwm.fraunhofer.de. URL: http://www.fraunhofer.de.

2. INNOVATIVE METHOD TO MANUFACTURE SELF-ASSEMBLING ROBOTS

As robots become easier to use, more flexible, and possess smart attributes such as navigation capabilities, they are finding greater opportunities in different sectors. Manufacturers and researchers around the world are working on developing novel manufacturing methods for producing robots with increased capabilities at significantly less cost and time. Researchers from a university in the USA have now developed a method for producing robots that have self-assembling capability.

A group of researchers from the Wyss Institute for Biologically Inspired Engineering at Harvard University and the Engineering and Applied Sciences at Harvard's School of Engineering and Applied Sciences (SEAS) have developed self folding robots. The researchers have used paper and Shrinky Dinks™, the children's toy that shrinks when heated, to develop a robot that assembles itself into a complex shape in four minutes, and crawls away without any human intervention. This innovation is said to have drawn inspiration from the self-assembly in nature, such as the way linear sequences of amino acids fold into complex proteins with sophisticated functions. According to the researchers, this novel innovation has significantly high scope for increasing the ways in which the robots could be manufactured in the future for various other applications. For instance, a group of robotic satellites that are sandwiched together, could be sent to space where they would be able to self assemble on their own for performing functions such as taking images and collecting data.

For this novel robot, a complete electromechanical system was developed and embedded into a fabricated flat sheet. The flat sheet is said to be composed of composite paper and polystyrene and a single flexible circuit board in the middle. A solid ink printer and laser machine were employed for manufacturing the flat sheet. The team then used computer design tolls to come up with the optimal design and fold pattern. Once the optimal design was obtained, the flat sheet was then attached with two motors, two batteries, and a microcontroller (which works as the robot's brain). Hinges were also used in this robot, which were programmed to fold at specific angles. Each hinge consists of embedded circuits that produce heat on command from the microcontroller. Heat that is generated then triggers the composites of the material in the robot to self fold in a series of steps. When the hinges are cooled after about four minutes, the polystyrene hardens thereby making the robot stiff, and the microcontroller then signals the robot to crawl away at a speed of about one-tenth of a mile per hour. This entire event is said to consume very minimal energy, which in turn makes the robot energy efficient. Currently, the robot prototypes developed by the researchers operate on the basis of a timer--they wait for about ten seconds after the batteries are installed, and then they begin to fold. The researchers are currently working on modifying the triggering of the folding by using an environmental sensor such as temperature or pressure. They believe that this method is complementary to three-dimensional (3D) printing, which also holds great promise for quickly and inexpensively manufacturing robotic components, but faces difficulty with regard to integration of electrical components.

Advantages of this novel method are that it helps manufacturers to develop robots with more capabilities and functions at a significantly less time. This method would also help in the manufacturing of inexpensive robots. Due to the above mentioned advantages and capabilities, this method has potential for adoption once it is commercially available.

Details: Kristen Kusek, Researcher, Wyss Institute for Biologically Inspired Engineering at Harvard University, 60 Oxford St, 4th Floor, Suite 403, Cambridge, MA 02138. Phone: +1-617-432-8266. E-mail: Kristen.Kusek@wyss.harvard.edu. URL: www.wyss.harvard.edu.

3. NOVEL THERMOELECTRIC GENERATOR FOR IMPROVING VEHICLE EFFICIENCY

On the order of more than half of the energy emitted from vehicles and other heavy equipment used in the US has reportedly been wasted in the form of heat. The energy is usually wasted when it is made to escape into the air. Now researchers from a university in US have found a solution to convert this wasted heat into energy for powering vehicles and other equipment.

Researchers from the department of mechanical engineering at the Massachusetts Institute of Technology (MIT), USA, have developed an innovative thermoelectric material that is capable of converting temperature differences into an electric voltage. The researchers have used nanotechnology to restructure and significantly boost the efficiency of one thermoelectric material thereby paving the way for more cost-effective thermoelectric devices. Using the above mentioned method, a novel thermoelectric generator (TEG) has been developed. The TEG is a one-square-inch, quarter-inch-thick module, which is capable of converting waste heat emitted by vehicles into electricity to lend those vehicles added power. In the TEG, electricity is generated when heat enters through the top of the module, and then moves through the semiconductor material--which is packed into the TEG--to the cooler side. The resulting motion of electrons in the semiconductor of the TEG under this temperature difference creates a voltage, which is then extracted as electricity. In conventional TEGs that are currently available in the market, atomic vibrations in the. materials could leak the heat from the hot to the cold side. In the method used in the TEG that has been developed, leakage of heat has been significantly reduced thereby leading to an increase in performance efficiency by 30% to 60% across various thermoelectric materials that could be used. The TEG is said to withstand a temperatures of 600 degrees C on its hot side while the temperature on the cold side is said to be 100 degrees C. With a temperature gradient of 500 degrees C, a module with an area of 4 cm is capable of producing 7.2 watts of power. For instance, when it is installed near the exhaust pipe of a car, the electricity that is converted by the TEG is said to be capable of powering the electrical components of the car. This electricity is essentially seen to reduce the load on the vehicle's alternator thereby reducing the cost associated with fuel consumption and also the overall emissions. The researchers are currently working on a project to improve fuel economy in passenger vehicles by 25% under the $9 million grant given by the US Department of Energy (DOE).

Some of the advantages of this novel TEG are that it significantly increases the efficiency of vehicles, reduces the cost associated with fuel, and lowers vehicle emissions. Since there is a global need for lowering emissions and increasing fuel efficiency of vehicles, this TEG has opportunities for significant adoption in the future. .

Details: Abby Abazorius, PR Contact, MIT News Office, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139-4307. Phone: 617-253-2709. E-mail: abbya@mit.edu. URL: www.mit.edu.

4. PATENT ANALYSIS OF FUSED DEPOSITION MODELLING

Fused deposition modeling (FDM) is a type of 3D printing, or additive manufacturing, technique. It employs two kinds of materials--a material for modeling, which constitutes the finished product; and a support material that is used as scaffolding for supporting the product that is being printed using the 3D printer. 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 it being extruded onto a base, which is known as the build platform. The nozzle and the base are controlled by a computer, which translates the dimensions of the object into X, Y, and Z co-ordinates that are required to be followed during the printing process. The extrusion nozzle in a typical FDM system is made to move over the build platform in both horizontal and vertical directions thereby drawing a cross section of the object to be printed on the platform. A thin layer of filament is then allowed to cool and harden so that it can be made to bind onto the layer beneath it. Once the layer is completed, the base is lowered by one sixteenth of an inch, which creates the space that is required for depositing the next layer of plastic. This process is employed in a wide range of industries, such as automotive, aerospace, and consumer goods. Industries use this process in their product development, prototyping, and manufacturing applications. The key advantages of this process are that products can be manufactured at a fast rate (within minutes to a few hours) with high accuracy to within around 0.005 inches; and small parts can be produced inexpensively. However, FDM works with only a relatively limited set of materials (a few plastics and ceramics) and can have size limitations. FDM was initially commercialized by Stratasys

From the patents that have been exhibited, one area of interest is using FDM to produce multi-colored 3D objects.

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.
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.
Selective deposition modeling using cw uv led curing	April 24, 2009/ EP 2271476 B1	3D Systems, Inc.	Jim Hong Lim, Hernando Vicente Angulo, John D. Clay	The present invention relates in general to solid freeform fabrication, and in particular to methods, systems and apparatus for selective deposition modeling using continuous ultraviolet (UV) radiation to cure layers of a build material to form three-dimensional structures or objects.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Convection cooling techniques in selective deposition modeling	October 20, 2004/ US 7427374 B2	3D Systems, Inc.	Jon Jody Fong	A convection cooling technique for selective deposition modeling utilizing a venturi duct to establish a low-pressure port for drawing a second flow of air into the duct. The second flow of air is drawn across a heat generating component in the selective deposition modeling apparatus. A low-pressure zone is established at the low-pressure port sufficient to meet the head loss that results when drawing the second flow across the heat generating component and into the venturi duct. A desired flow rate is achieved at a pressure drop that is greater than that possible by the direct use of a fan. The cooling system is well suited for use in providing steady state cooling of radiation exposure systems used in selective deposition modeling to initiate curing of the layers of dispensed material.
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 modelling.

Picture Credit: Frost & Sullivan

Back to TOC