TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

31st July 2015

1. USING ROBOTS FOR 3D PRINTING A PEDESTRIAN BRIDGE

Three-dimensional (3D) printing is being increasingly used in various applications, such as prototyping or production of parts or devices in industries such as automotive, aerospace, healthcare, and so on. To date, 3D printing has not been used to create very large structures or objects for real-world applications.

MX3D, a research and development company based in The Netherlands, has developed robotic 3D printing technology and innovative extrusion technology. The robots can 3D print metals or resins in mid-air without requiring support structures. The technology can also be used for 3D printing large structures.

MX3D has a project to 3D print an intricate, functional steel bridge.

Each robot has 6-axis arms fitted with specially designed 3D tools for various activities. The tools enable the robot to act as a welding machine and heat metals up to 1500 degrees C. The robot can also print metals in mid-air without the need for a support structure.

Autodesk is collaborating with MX3D to provide technology and technical assistance for this project. One of the main software platforms provided by Autodesk is Dreamcatcher, a generative design software tool, which is used to achieve robotic printing process in mid-air. Since the robotic arms are freed from the confines of an enclosure and can print in any direction, the theoretical size of the print volume is limitless. However, cooling the metals below a particular temperature to start the extruding process takes a long time. This makes the whole printing process rather slow. MX3D's team is currently involved in solving this problem.

MX3D is currently working on a project of using its robots to build a steel pedestrian bridge over a canal in Amsterdam. The bridge is being designed by

Dutch designer and artist Joris Laarman, who is the founder of Joris Laarman Lab. This steel is as strong and hard as normal steel. It will continuously flow at a controlled phase with precise measurement and form the lines along the derived path according to the design. At the beginning of the project, the multi-axis material extruding robotic arms were designed to freeform and print layer by layer using a fast curing resin on any surface, at any desired angle. Then an advanced welding machine was fitted to these robotic arms and upgraded to print metals by fusing bits of molten metals.

A few issues, such as robot disorientation, nozzle burn through, robot tip melt, and diffuser position change, were faced during the initial stages and were solved by analyzing and optimizing the robots' path speed, torch angle, and diffuser position. The robotic arms were programmed with process monitoring software to first create worm-like blobs, then make straight line and complex curves, and finally make double curve oval tubes. Since these robots do not use the square box concept, they will be able print their own support and bridge as they move along the canal.

For this project, MX3D has collaborated with Amsterdam City Council, Joris Laarman Lab, and companies such as ABB robotics, Delcam, Gemeente, and Heijmans. MX3D's 3D printing robots and software will make an impact in the construction industry by 2017

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2. COST-EFFECTIVE METHOD FOR PRODUCING ALUMINIUM ALLOYS USING ULTRASOUND

Over the recent years, scientists have been increasingly concentrating on analyzing and optimizing manufacturing and production processes in such industries as metals to increase the efficiency of the processes and methodologies and at the same time make the processes simpler, cleaner, and environmentally friendlier.

A group of researchers from the Brunel Centre for Advanced Solidification Technology, Brunel University London, has discovered a novel process for de-gassing molten aluminum alloys. This process has benefits in many manufacturing industries such as automotive and aerospace.

If molten aluminum alloys are not de-gassed properly, the resulting solid aluminum alloy will contain many pores and cannot be used for any other manufacturing processes. This porosity issue occurs when the dissolved hydrogen (naturally occurring) in the molten aluminum alloy (at 700 degrees C) is not treated properly.

To prevent the formation of pores in aluminum alloy, the researchers used ultrasound to de-gas the aluminum alloy. The results revealed that this method is more efficient, eco-friendly, and cost-effective than the conventional process of argon rotary degassing. The argon rotary degassing method is expensive since it employs argon gas. Argon is produced by liquefying air by an energy intensive process, which makes this noble gas expensive. Also, the high consumption of energy makes this process less eco-friendly. The argon rotary degassing method also uses graphite impellers that can break or chip during the degassing process and mix with the aluminum alloy thereby contaminating it, which renders the aluminum alloy useless for manufacturing.

The ultrasonic method uses an ultrasonic transducer to de-gas the molten aluminum alloy. A plate sonotrode is used to create ultrasonic vibrations as the molten alloy moves through the de-gassing chamber. As the process continues, acoustics are measured and adjusted for the molten alloy to reach an ideal de-gassing level. This process was initially conducted at a laboratory scale and was scaled up to a larger scale for testing its efficiency over large volumes of aluminum alloy. During trials, up to 150 kg of aluminum alloy was taken as a batch and tested using ultrasonic method to perform degassing. The results obtained were very successful.

Initially, when the ultrasound process was used by the same team of researchers in 2014, different types of sonotrode devices were used to obtain the highest efficiency of degassing. A sonotrode is a device that consists of piezoelectric transducers that are attached to a tapering metal rod. The transducers create ultrasonic vibrations that are used in various applications in fields such as medicine, aviation, and for industrial processes. The first prototype of ultrasonic degasser used by the researchers consisted of an S-shaped sonotrode in the de-gassing chamber. Even though the de-gassing process was efficient, it was not feasible for a bigger batch of aluminum alloy. At present, the researchers have incorporated changes to the process and to the sonotrode for processing bigger batches of aluminum alloy. They have optimized the process for large volumes of aluminum alloy by altering the shape and dimensions of a plate sonotrode, which is placed at the bottom of the degassing chamber.

The research team is currently focusing on scaling up the new process and conducting trials with large batches (batch of 500 kg) of aluminum alloy. This novel process is promising in the field of automobile and aerospace manufacturing. If the efforts of the research team to optimize this process for large scale manufacturing succeed, it will greatly reduce the manufacturing cost of automotive and aerospace parts such as full body frame, chasis, and so on.

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3. LASER ARC COATING METHOD FOR EXTENDING LIFE OF ENGINE COMPONENTS

To decrease friction, improve thermal resistance, and increase durability of engine parts and small components, different types of surface treatment and coating processes are being researched and implemented in the automotive components manufacturing industry.

Many large scale manufacturing industries are using a carbon-based diamond-like carbon (DLC) coating method to coat components such as pistons rings, small pins, and so on. However, the DLC coating method has disadvantages, such as poor adhesion, limited thickness, inability to withstand high stress levels, and degradation in the coated components' mechanical properties when subjected to heat treatment.

Researchers from the Fraunhofer Institute for Material and Beam Technology, led by Hans-Joachim Scheibe, Volker Weihnacht, and Andreas Leson, have developed a new laser arc coating method. The team was successful in producing a tetrahedral amorphous carbon coating called hydrogen-free ta-C coating. This coating is much higher in resistance, strength, and hardness than DLC coatings.

A laser pulse is passed through the carbon cathode in vacuum to initiate the process. This results in the formation of an arc between the cathode and the anode, and plasma consisting of carbon ions is produced. The carbon ions are deposited on the work piece kept in the vacuum, and they eventually form the coating. While the laser arc method is suitable for coating components on a smaller scale; for coating components on an industrial scale, a pulsed laser and a graphite cylinder are required. As the graphite cylinder rotates, the pulsed laser is vertically scanned across the cylinder. Due to the rotation of the cylinder and the scanning motion of the pulsed laser, the cylinder is evenly converted to plasma.

The magnetic field present in the process filters any impurities such as dirt and foreign particles, and guides the plasma to give an smooth, even, and consistent coating. Carbon is coated as layers on the component to provide a thickness of up to 20 micrometers, which are much thicker than the coating produced by the DLC process. It is been concluded by the researchers that hydrogen-free ta-C coating method can be used to coat engine components on a voluminous scale.

Many automotive companies are conducting research on reducing fuel consumption of vehicles. BMW is one such company that is working on implementing hydrogen-free ta-C coated components for its car engines to decrease friction and increase efficiency.

The hydrogen-free ta-C coating method enables reduction of friction of the coated engine components to almost zero, thereby increasing overall vehicle efficiency. This novel method can be a step toward manufacturing fuel- and performance-efficient vehicles in the automotive industry. The coating technology is expected to be commercialized by the end of 2017 and impact the automotive industry by 2020.

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4. PATENT ANALYSIS OF REAR TORSION BEAM

The rear torsion beam, also known as a twist beam, is a vehicle suspension system that is attached in the front of the vehicle along with the suspension arm of the axle. The beam has two trailing arms, along a cross member, called as a gusset beam. The gusset beam serves as an anti-roller bar when fixed with the wheel of the vehicle. The other main components of the rear torsion beam are the spring sheet, gusset plate, and damper bracket. These parts are welded at precise locations and angles according to specifications provided by the vehicle manufacturer.. The torsion beam rotates along its axis as the wheel rotates vertically providing suspension and stability for the vehicle.

Since rear torsion beams differ from vehicle to vehicle, most of the patents are filed by automotive companies and automotive part manufacturers according to their required designs. The bulk of the patents correspond to development of new types of torsion beams. Interestingly, it is observed that most of the patents filed for rear torsion beams in the last 18 months are from China.

One of the interesting patents (US 2014012025), filed by Sungwoo Hitech Co. Ltd., pertains to a rear suspension system of a coupled torsion beam. Another notable patent (KR 1020140035104), filed by Hyundai Motor Company, pertains to coupled torsion beam axle for rear type suspension.

Title	Publication Date/ Publication Number	Assignee	Inventor	Abstract
Rear torsion beam of rear wheels of car and rear wheel suspension system with rear torsion beam	July 27, 2014/ CN 103935208	Han Jianou	Han Jianfang	The invention relates to a rear torsion beam of rear wheels of a car and a rear wheel suspension system with the rear torsion beam. The rear torsion beam comprises a torsion cross beam. A left dragging arm and a right dragging arm are fixed to the two ends of the torsion cross beam respectively. The horizontal center line of the torsion cross beam shifts to the tail of the car by a certain shifted distance R relative to the central axis of a left rear wheel hub and the central axis of a right rear wheel hub. The tail end of the left dragging arm and the tail end of the right dragging arm are fixed to the two ends of the torsion cross beam respectively, so that the U-type rear torsion beam is formed. The rear torsion beam is simple in structure and reasonable in design, enables the volume of a bin of an oil tank or a battery box to be increased by 25%-40%, the volume of the bin is increased, the size and the volume of the battery box or the oil tank of the car are further increased, the runtime is further prolonged, and the social value and the market promotion value are high.
Rear suspension of hydraulic interconnected torsion eliminating suspension	July 16, 2014/ CN 103921647	Jiangsu University	Wang Ruochen	The invention discloses a rear suspension of a hydraulic interconnected torsion eliminating suspension. The rear suspension comprises equal armed levers, springs, vibration absorbers, a double acting hydraulic cylinder, a smooth pipeline, an electric control unit and a display. The left and right cylinders experience equal force since the vertical force of the suspension on one side consistently penetrates the interconnection of the left and right cylinders through the serial connection of a rear-suspended hydraulic cylinder and a traditional suspension structure (interconnecting members of springs and absorbers), and accordingly the left and right parts of the rear suspension experience equal force. The direction of the force of the suspension is changed through the equal armed levers, so that the purpose of reducing the height of the rear suspension to be the same of the front traditional suspension can be achieved. The rear suspension has the advantages that grounding performances of tires are improved greatly, part of vehicle torsion load is eliminated effectively, and smoothness of driving and passing performances on rough roads are improved

Automobile, rear torsion beam assembly of same and processing technique of rear torsion beam	May 28, 2014/ CN 103818209	Anhui Jianghuai Automobile Co. Ltd.	Zhang Linlin	The invention discloses a processing technique of a rear torsion beam assembly of an automobile. The rear torsion beam assembly comprises a cross beam (11), longitudinal arms (12), spring trays (13) and hub supports (14). The processing technique includes the following steps: processing blanks to acquire the cross beam (11), the longitudinal arms (12), the spring trays (13) and the hub supports (14); welding the cross beam (11) with the longitudinal arms (12), welding the spring trays (13) with the cross beam (11) and the longitudinal arms (12), and welding the hub supports (14) with the longitudinal arms (12); performing face processing on end faces, matched with wheels, on the hub supports (14) to enable the hub supports (14) to meet wheel assembling requirements. By the processing technique, positioning accuracy when the rear torsion beam assembly is assembled with the wheel can be guaranteed. The invention further discloses the automobile and the rear torsion beam assembly of the same.
Connecting structure of automobile rear torsion beam assembly and automobile body component	May 28, 2014/ CN 103818210	Lifan Industry (Group) Co. Ltd.	Gou Jun	The invention discloses a connecting structure of an automobile rear torsion beam assembly and an automobile body component. Pull arms (4) are arranged at the left end and the right end of the rear torsion beam assembly (1), a mounting groove (3a) is formed in the position, corresponding to a rubber bushing component (2), of the automobile body component (3), guide and locating reinforcing plates (6) are symmetrically fixed in the left groove wall and the right groove wall of the mounting groove (3a), inverted U-shaped locating gaps (6a) are formed in the guide and locating reinforcing plates (6), the two ends of the rubber bushing component (2) are arranged in the locating gaps (6a) of the corresponding guide and locating reinforcing plates (6), a bolt (5) penetrates through a mounting hole in the mounting groove (3a) and a central hole of the rubber bushing component (2), and the rubber bushing component (2) and the automobile body component (3) are fixedly connected together. The guide and locating reinforcing plates are additionally arranged, the guide and locating function can be achieved in the assembling process of the rear torsion beam pull arms, the assembling operation is simpler and more convenient, and assembling efficiency is effectively improved.
Rear suspension system of coupled torsion beam axle	May 8, 2014/ US 20140125025	Sungwoo Hitech Co. Ltd.	Lee Mun Yong	The present invention relates to a rear suspension system of a coupled torsion beam which comprises a torsion beam and trailing arms connected to ends of the torsion beam by welding, wherein a gap with a predetermined length is formed between the torsion beam and the trailing arm.

Bushing for torsion beam of rear axle of automobile	April 2,2014/ CN103697097	ZF Rubber Metal (Shanghai) Co. Ltd.	Liu Tao	The invention discloses a bushing for a torsion beam of a rear axle of an automobile, and belongs to the field of parts for automobiles. The bushing comprises an inner sleeve, a bushing body and an outer sleeve which are sequentially nested in one another from the inside to the outside. The inner sleeve, the bushing body and the outer sleeve are integrally vulcanized and formed, and two stress grooves which are axially perforated through the bushing body are symmetrically formed in the bushing body; each stress groove comprises a left end surface, a right end surface, an outer side surface and an inner side surface which encircle to form the stress groove, and stress dispersion structures are symmetrically arranged at a joint of the left end surface and the outer side surface of each stress groove and a joint of the outer end surface and the inner side surface of the stress groove. The bushing for the torsion beam of the rear axle of the automobile has the technical advantages that the bushing is not easy to break when the automobile runs, and accordingly the durability of the bushing is greatly improved; requirements of an automobile assembly plant on the dynamic stiffness and the static stiffness of the bushing for the torsion beam of the rear axle of the automobile can be met, and increase of the production cost of products can be prevented.
Coupled torsion beam axle type rear suspension	March 21, 2014/ KR 1020140035104	Hyundai Motor Company	Park, Baek Soon	Disclosed is a coupled torsion beam axle type rear suspension. The disclosed coupled torsion beam axle type rear suspension includes a torsion beam and a trailing arm connected to both ends of the torsion beam, respectively, wherein a spring seat unit for mounting a spring on the trailing arm can be integrally formed. COPYRIGHT KIPO 2014
Auxiliary torsion spring installation tool of automotive ignition rear cover rotating block	March 19, 2014/ CN 103639986	Huangshan Automaster Electric Co. Ltd.	Wang Chunhua	The invention discloses an auxiliary torsion spring installation tool of an automotive ignition rear cover rotating block. The auxiliary torsion spring installation tool comprises an upper die and a lower die, the upper die comprises a die handle plate, a first slant wedge, a second slant wedge and a die handle, and the first slant wedge, the second slant wedge and the die handle are installed on the die handle plate; the lower die comprises a bottom plate, a guide plate and a limiting plate, and the guide plate and the limiting plate are installed on the bottom plate; the guide plate is provided with a sliding block which is used in cooperation with the first slant wedge for blocking a torsion spring pin; the limiting plate is provided with a locating shaft which is used for rotating a torsion spring, and a gear is installed on the locating shaft; the bottom plate is further provided with a track groove, and a rack matched with the gear is installed in the track groove; the end of the rack is provided with an idler wheel in butt joint with the rack, and the second slant wedge is matched with the rack through the idler wheel. According to the torsion spring installation clamp, the rack drives the gear to perform rotary motion, the torsion spring is pressed into an ignition rear cover rotating block

				groove after being rotated to a set angle, manual operation is replaced, the labor intensity is lowered, and the production efficiency is improved.
Torsion beam rear axle crossbeam	January 22, 2014/ CN103522864	Shanghai Huizhong Automotive Manufacturing Co. Ltd.	Xu Guang	The invention aims to provide a torsion beam rear axle crossbeam. The torsion beam rear axle crossbeam is characterized by comprising a crossbeam body, and the cross section of the crossbeam body is in a U shape; two longitudinal edges of the crossbeam body are provided with longitudinal upsiding down edges, and the belly portions of the two ends of the crossbeam body are higher than the belly portion of the middle section of the crossbeam body; transition sections are arranged from the end portions of the crossbeam body to the middle section of the crossbeam body, two reinforced plates are arranged on the inner side of the crossbeam body and extend towards the middle of the crossbeam body respectively from the different end portions of the crossbeam body, and the two sides of each reinforced plate are connected with the
Vehicle torsion bar beam rear suspension	December 18, 2013/ CN103448502	Shanghai General Motors Co. Ltd.	Tang Xiaofeng	The invention discloses a vehicle torsion bar beam rear suspension which comprises a main beam, a first side beam and a second side beam. The first side beam and the second side beam are connected at two ends of the main beam respectively, the two ends of the main beam are connected with the waists of the first side beam and the second side beam, the cross section of an end portion of the main beam is round, the waist of the main beam is provided with an opening, and the cross section of the waist of the main beam is arc-shaped. Compared with the prior art, the vehicle torsion bar beam rear suspension has the advantages that machining process of the main beam is simplified, weight of the main beam is lowered, and cost is saved.

Exhibit 1 depicts patents pertaining to rear torsion beams.

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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