TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

18th July 2014

1. NOVEL MATERIAL FOR DEVELOPING LOW-COST ROBOTS

The applications for robots in different industrial sectors have been increasing, and researchers around the world are looking at various ways to reduce the cost of robots that are being manufactured in addition to increasing their capabilities. A university in USA has developed a novel material that is expected to address the above mentioned factors.

Researchers from the Massachusetts Institute of Technology (MIT), by collaborating with a robotics company called Boston Dynamics in USA, have developed a novel phase changing material made from wax and foam. This material is said to be capable of switching from hard and soft states. The researchers believe that this material could be used for building low-cost robots that are capable of changing their states, for instance deformable surgical robots could be built using this novel material. Robots using this material would be able to move through the body to reach a particular point without damaging any of the organs or vessels in the human body. The other application area for the robots using this novel material is the search and rescue operations where the robots would be able to squeeze through rubbles looking for survivors.

In order to build a material that is capable of shifting between soft and rigid states, the researchers have coated a foam structure in wax. Foam has been chosen since it can be squeezed into smaller fractions of its normal size and can retain its original shape when released. The wax coating can change its hard outer shell into a soft bendable surface with moderate heating. This transformation has been achieved by running a wire along each of the coated foam support and applying heat to melt the surrounding wax. By turning off the current again, the material is allowed to cool down and return to its rigid state. In addition to switching the material into soft state, heating of the wax in the above mentioned manner would also help in repairing any of the damages sustained to

the robot, thereby making this novel material self-healing. To study the properties of the material in detail, a three-dimensional (3D) printer was employed to build parts of the 3D robot using this novel material. The use of 3D printer has enabled the researchers to control the position of the structure and pores of the material. From the various tests that were carried out, it has been found that the material was seen to be more rigid and efficient for building low cost robots. Researchers are currently investigating the use of other unconventional materials for robots such as magnetorheological and electrorheological fluids. The above mentioned materials consist of a liquid with particles suspended inside them which allows them to switch from soft to a rigid state by applying a magnetic or electric field. Defense Advanced Research Projects Agency (DARPA), USA, has funded this project for developing a novel material that could be sued for building low cost robots that could be used for a wide range of applications in different industrial sectors.

Some of the advantages of this material are that, it enables the development of low cost robots with significantly high capabilities, which in turn increases the applications for robots in various market sectors. Due to the above mentioned capabilities and advantages, this material has potential to be adopted on a large scale by for building robots in the future.

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2. AERIAL ROBOT FOR INSPECTING INFRASTRUCTURE

Infrastructure, such as buildings, industrial plants, and bridges, are subjected to heavy loads and extreme weather conditions, which results in damage over a course of time. Currently, most of the infrastructure inspections are carried out by humans, which sometimes are considered to be dangerous for their safety. To address the above mentioned problems and increase the safety for humans, developments are underway to automate the inspection process by using robots. Researchers from a research institute in Germany have developed a novel microrobot for addressing the above mentioned challenges.

Researchers from the Fraunhofer Institute for Non-Destructive Testing IZFP in Saarbrücken, Germany, have developed micro-aerial robots that could be used for inspecting buildings. When compared to conventional methods, the

inspection carried out by this aerial robot is said to be more convenient and efficient in terms of reducing the total time taken for inspection. For instance, the conventional method takes two or three days for carrying out the inspection process, but this aerial robot is said to finish the same inspection process in a time of two to three hours. The cracks and other flaws are digitally photographed in high resolution, which allows quick conclusion about the state of the structure that is being inspected. Researchers have also said that this robot could be equipped with thermal imaging cameras if required for applications. The individual pictures that are captured by the robot are automatically transmitted to the computer of the user where it is combined to create an overall picture and the resulting 2D and 3D models are used for analyzing the structure. It has been seen that aerial robots have been used for a variety of tests and the results have been positive with respect to the working of the robot. The device is equipped with eight electric motors thereby allowing it to safely land even if one of the motors fail. Researchers are now working on developing a complete software suite for recognizing the damages, a database for documenting the images, and for automating the entire analysis operation. In addition to creating a software suite, researchers are also working on integrating navigation sensors into this robot for automatically controlling its navigation in the future. For instance, the sensors would allow the robots to carry on in a predetermined pattern. With all the above mentioned improvements and developments, the novel aerial robot is expected to be commercially available for wide scale adoption by 2017.

Some of the advantages of this aerial robot are that it significantly reduces the risk that is caused for human's who are involved in the inspection of buildings and other infrastructures and also increases the efficiency of the process by reducing the time that is taken for inspection. This aerial robot would have opportunities to be adopted on a large scale once it commercialized due it to its ease of use and high efficiency.

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3. TECHNIQUE TO DEVELOP LOW-FRICTION MATERIALS

A technology or method for controlling the friction co-efficient of a material can be a key factor in the development of newer materials. This is due to the worsening of the global environment and energy issues. Reduction of friction in various applications is seen to have a direct affect on energy conservation. Coating an existing structural material is the widely adopted technology for controlling the friction. The drawback seen with the existing method is that the frictional property of a coating changes considerably due to the differences in the crystal orientation of the coating material. In order to overcome the above challenges that are currently seen with the conventional methods, researchers in Japan have developed a novel technique for addressing the above mentioned challenges.

Researchers belonging to the National Institute for Materials Science (NIMS), Japan, have developed an innovative technique for developing friction materials with a desired frictional property. This method is expected to increase the speed with which the materials with different friction co-efficient are being developed. For instance, with this method, it would be possible to develop low-friction materials for reducing energy loss and high-friction materials required for high-performance brakes. In this novel method, researchers have used a combination of technologies for the development of frictional materials for specific applications. This method is said to enable the development of highly efficient materials that require only one trial experiment thereby eliminating the need to conduct multiple experiments before using the material for an application. For instance, zinc oxide (ZnO), which is a general metal oxide, exhibits a low-friction phenomenon when its preferred crystal orientation is optimized in order to find the optimum preferred crystal orientation and structure required for low-frictional property. Conventionally, it was necessary to create a large number of samples with varied crystal preferred orientations by changing the coating conditions and evaluate their crystal preferred orientation and frictional property, which takes a long R&D period. In this research, the crystal structure of each microscopic region of the material was analyzed by changing the conditions of the coating film. By doing so, researchers have been able to measure the friction co-efficient of the material at a particular location. Researchers believe that the controlling of the preferred crystal orientation of the material significantly increases the potential for the development of various friction-based materials in the future.

This technique offers various advantages--it enables development of friction-based materials that can increase energy saving capacity in various applications in different industrial sectors, and increases efficiency and longevity of products. Due to the various advantages and capabilities that this technique possesses, it has the potential to be adopted on a significant scale once it is commercially available in the market.

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4. PATENT ANALYSIS OF ELECTRO SLAG WELDING

The electro slag welding process is a type of arc welding process. In this type of welding, the weld joint is created by using molten slag. The molten slag is produced by melting the filler metal or electrode by means of heat. In this type of welding, the arc is produced by placing a piece of steel wool between the electrode and the work piece that is to be welded. When sufficient amount of molten slag or flux that is required for welding the work piece is produced, the generation of electric arc is stopped. Once the slag is produced, electric current is made to pass the molten pool of slag. Usually the temperature of this molten slag ranges from 16000 to 19000 degrees C, which is sufficient to melt the filler metal and the work piece. The melted electrode is fused to the base metal and the metal that is melted is deposited under the joint that is to be welded. The melted metal is then allowed to solidify slowly thereby producing a weld bead making the electro slag welding a progressive melting process and the solidification takes place from the bottom to the top of the work piece that is to be welded. The molten flux used in this type of welding also acts as a shielding for the weld metal protecting it from harmful atmospheric harmful gases. The molten flux also helps in reducing the impurity of molten metal as a slag. Some of the advantages of this welding process are that, it can be used for welding large work pieces having thickness of up to 45 cm. The other advantage of this welding process is that it can be used for welding work pieces made of aluminum and other special steels.

From the patents exhibited below, the recent filings indicate developments in such areas as electroslag pressure welding devices, filament electroslag welding with alternating electrode weld parameters.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Electroslag pressure welding device	January 24, 2013/ CN 203018907 U	Installation Engineering Company of Heilongjiang Province	Zhang Xiaodong, Li Xuejun, Li double, Zhi Xin, Chen, the Shixi Chen	The utility model provides an electroslag pressure welding device. A reinforced concrete structure is widely applied, and the reinforcing steel bar welding amount is increased accordingly, a large number of tests and researches are carried out by people in the industry and a wide range of experimental parameters are generated and are difficultly mastered so as to directly influence the welding processing quality. The electroslag pressure welding device comprises a lever (9) which is hinged at the front end of an operating handle (11); the operating handle is hinged on a fixed connecting plate (16); a slide bar (15) and a lower fixture (7) are fixed on the fixed connecting plate; the slide bar is arranged in a slide sleeve (14); a limiting mechanism (10) is fixed on the slide sleeve which is connected with an upper fixture (2); an upper reinforcing bar (1) and an upper electrode (3) are arranged on the upper fixture; a lower reinforcing steel bar (8) and a lower electrode (17) are arranged on the lower fixture; and a welding flux bucket (4) is arranged between the upper reinforcing steel bar and the lower reinforcing steel bar. The electroslag pressure welding device is applied to welding.
Filament electroslag welding machine	December 19, 2012/ CN 202951972 U	Weishan County Technical School	Wu Shuo, Huang Lei, GAO Yong Jian, Wang Shouqiang	The utility model relates to a filament electroslag welding machine which belongs to steel structure production and processing equipment. The filament electroslag welding machine comprises an alternating-current welding power source, a filament feeding mechanism, a welding mechanism and a water-cooling forming sliding plate lifting mechanism, wherein the welding mechanism comprises a welding machine head, an electroslag tank, a metallic molten pool, an electric conduction rod and a filament, the welding machine head is connected with a guide rail and a programmable logic controller (PLC), and the PLC is connected with the alternating-current power source; the temperature of the electroslag tank is between 1800 and 2000 DEG C; and the water-cooling forming sliding plate lifting mechanism comprises a copper water-cooling forming sliding plate. According to the filament electroslag welding machine, the PLC is used to control the welding machine head, an operator can accurately set welding parameters, and the electroslag welding machine can be used for accurately welding according to the set parameters. Consequently, the filament electroslag welding machine has the advantages of simplicity in operation, high welding quality, high welding velocity and the like.
Improved electro-slag welding machine	February 22, 2012 / CN 202517189 U	Heavy Metal Structure Co., Ltd. in Tianjin	Xu Yuantao, Chen Po	The utility model provides an improved electro-slag welding machine, comprising a machine body, a welding machine head and conduction nozzles. The length of the conduction nozzles is determined according to the thickness of a work piece board to be welded; the electro-slag welding machine has a multi-wire feeding manner and comprises a plurality of the conduction nozzles; and the both parts of each conduction nozzle are bond through a plurality of fixing rings at the different positions of the conduction nozzles, so that a step distance between each two adjacent conduction nozzles is adjusted by adjusting the size of the fixing rings at the different positions of each conduction nozzle. The improved electro-slag welding machine provided by the utility model has the advantages and the positive effects as follows: with the adoption of the technical scheme, the welding requirements of steel boards with different thicknesses can be met. Meanwhile, the improved electro-slag welding machine is economical and practical, and the production period is shortened.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Electroslag welding device	March 22, 2011/ CN 202123318 U	National Laboratory Research Institute	Zhuangsheng Zhi, Lin Keqiang	The utility model discloses an electroslag welding device which is used for connecting a first structure and a second structure and comprises a welding wire, a first mold, two second molds and a control unit. The first mold is connected with the bottoms of the first structure and the second structure in a bridging way. The second molds are respectively connected among the two opposite side faces of the second structure and the first structure; areas of the inner side faces of the second molds in position close to a first welding surface of the first structure form chamfered oblique surfaces, wherein the inner side faces of the second molds are close to each other; and the chamfered oblique surfaces leads a containing space defined by the upper surface of the first mold, the inner side faces of the second molds, the first welding surface and a second welding surface to gradually expand along the direction close to the first welding surface. The control unit is used for conveying the welding wire to extend into the containing space and powers on the welding wire to generate electric arcs.
Electroslag welding with alternating electrode weld parameters	November 16, 2010/ US 20120118859 A1	Danks Daniel R, Turpin Robert B	Danks Daniel R, Turpin Robert B	Electroslag welding is a single pass welding process that may be used to join two or more work pieces at a weld location. In general, electroslag welding may include electrical resistance heating, using electrodes, a molten slag pool positioned between the work pieces, cooling shoes and a base plate. As the weld progresses, the electrodes may be fed into the molten slag pool which may fill the void between the work pieces, and cool to form the weld. The cooling shoes and base plate may be removed and excess weld material may be removed to complete the weld process.
Electroslag welding with variable balance, constant potential, alternating current, square wave welding power supply	May 25, 2010/ US 20100308019 A1	Bong William L	William L. Bong	A DC balanced square wave power source, controlled in a constant voltage mode, for ESW and ESW-NG welding systems and methods can be matched with variable speed wire electrode feeders, multiple guide tubes, articulated air-cooled cooper welding shoes, and multiple pass ESW welding systems, thus gaining the following advantages, namely, controlling weld bead shape, reducing base metal dilution, reducing total heat input into the parent material, and reduction or elimination of any DC magnetic field in the weld cavity.
System and method for electroslag welding spliced vertical box columns	April 13, 2009/ WO 2010080169 A1	Bong William L	William L. Bong	A system and method for welding spliced vertical box columns with an electroslag welding system. The system includes a welding fixture having opposing, paired and positionally adjustable welding shoes, run-off tabs, and sumps affixed at the junction of box columns to be spliced. A distributed control electroslag welding system, articulating boom, welding torch and consumable guide tube oscillator feed provide molten flux within the shoes filling from the sump to the run-off tab.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Air-cooled copper shoes for electroslag welding applications	June 01, 2009/ WO 2009149017 A1	Bong William L	William L. Bong	Adjustable articulated air-cooled copper welding shoes, capable of being controlled between 800 to 1000 degrees Fahrenheit during Electroslag welding operations, result in faster welds, smaller heat affected zone in the workpieces welded, and less base metal dilution. The shoes thus provide a smaller weld grain structure and stronger bonds in the weld fusion zone.
Arc striking device for electroslag welding	October 10, 2008/ CN 201283477 Y	Henan Tianfeng Steel Structure Co., Ltd.	Liliang Hai, Xu Zhimin	The utility model relates to an electroslag welding arc striking device comprising an arc striking block, wherein the arc striking block which is split along the axial direction is in a separated round platform shape, and a locking ring which locks the separated round platform is arranged on the circumferential direction of the arc striking block. The electroslag welding arc striking device of the proposal is characterized in that the locking ring locks the separated round platform when in use, after finishing the welding, a loading and unloading handle is tapped downwards, and the locking ring and the separated round platform are separated, after losing the locking function of the locking ring, the separated round platform can be easily separated and is easy to withdraw the arc striking device after the separation.
System and method for electroslag welding spliced vertical columns	September 23, 2008/ WO 2009045782 A1	William L Bong	William L Bong	A system and method for welding spliced vertical columns with an electroslag welding system. The system includes a welding fixture having opposing, paired and positionally adjustable welding shoes, run-off tabs, and sumps affixed at the junction of columns to be spliced. A distributed control electroslag welding system, welding torch, and consumable guide tube oscillator feed provide molten flux within the shoes filling from the sump to the run-off tab.

Exhibit 1 depicts patents related to electro slag welding.

Picture Credit : Frost & Sullivan

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