TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

04th July 2014

1. NOVEL SHAPE MEMORY ALLOY-BASED MATERIALS FOR INDUSTRIAL APPLICATIONS

Shape memory alloys (SMAs) have the ability to change shape and return to retain the original shape of the products that they are made of. Due to this ability, SMAs can be beneficial in commercial products as well as technical applications such as thermostats, stents, and micro actuators. Researchers have now shown that SMAs could be useful in the building industry, for instance in the reinforcement of bridges.

Researchers from the Empa Swiss Federal Laboratories for Materials Science and Technology, Switzerland, have found that a concrete beam with reinforcing rods that are made using SMAs could be activated by using heat. The drawback with concrete is that it would not be able to return to its original shape without exerting a pre-stressing force on the beam. In order to overcome the above mentioned drawback, the researchers working on this project have heated the SMA rods by passing an electric current. This in turn eliminates the need for using an elaborate tentioning systems and jacket tubes that are currently being used as conventional pre-tensioning techniques.

Nickel titanium alloys are not that suitable for use in the infrastructure or construction sector. The iron-based SMA products are much more attractive in this industry since both the cost of raw materials and processing are less expensive. The drawback with the iron-based SMAs is that, in order to activate the memory effect of the material, it has to be heated to a temperature of up to 400 degrees C. This temperature is considered to be very high for applications that contain concrete and other heat sensitive materials. Researchers working on this project have developed a novel iron manganese silicon SMA alloy that could be activated at a significantly low temperature of 160 degrees C, thereby making

it suitable for applications containing concrete. While developing this SMA alloy, the researchers have designed a range of virtual alloys using thermodynamic simulations before selecting a promising combination. Once the most suitable combination was selected, the prototype of products using the novel material was then manufactured in the laboratory. From the various tests that were carried out on the prototype, it was seen that the characteristics of the materials were well suited for infrastructure applications. The materials developed in this project could be manufactured on an industral scale for various other industrial applications in the future.

Some of the advantages of the SMA-based materials are that they could help in developing new products for the various industrial applications in the years to come. Since the new materials have various capabilities and advantages, they have opportunities to be adopted on a large scale once they are commercially available for wide scale adoption.

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2. COLLABORATIVE LEARNING ALGORITHM FOR ROBOTS

Machine learning is a technology by which computers learn novel skills by using patterns in training data. This technology is used as a basis for development and advances in artificial intelligence, voice recognition, and self-parking of cars. This technology is also used autonomous robots that are used for building models of their environments. The drawback with implementing the machine learning technology for autonomous robots is that robots are able to work efficiently in collecting the data when they are made to work as a group when compared to working alone. Some of the factors such as power constraints, communication, and computation are seen as the major factors for significant decrease in efficiency of autonomous robots when they are made to work alone. Researchers from the Massachusetts Institute of Technology (MIT), USA, have developed a novel algorithm to address the above mentioned drawback in autonomous robots

The researchers have developed a novel algorithm that has the potential to make autonomous robots work more efficiently while working alone. Using this algorithm, distributed agents such as robots exploring a building would be able to collect data and analyze the data that is obtained individually. The other key capability of this algorithm is that it allows pairs of robots passing each other in a hall or a production floor to exchange the analysis between each other. Based on the various tests that were carried out, it has been found that the distributed algorithm has the potential to outperform a standard algorithm that works on data collected at single location. For instance, optimization of data would be difficult when there is only one computer used to learn a model from a single large batch of data. With this new algorithm, researchers the have succeeded in breaking the data into smaller batches, which is processed by individual robots, which is then combined and shared between the groups of robots. This procedure of breaking down data is said to be robust and flexible. This algorithm is relatively simple, thereby allowing the robots to have a clear understanding of the size of the objects in a particular location in addition to the number of objects that can be placed in the specific location. Over time, the robots would be able to build their own catalog of the location and the content in the specified location. This information would be used by the robots to communicate with each other and eliminate the problem of overlapping their work. The potential application sectors for this novel distributed algorithm are multiple autonomous agents such as multiple autonomous land and airborne vehicles.

Advantages of this novel algorithm are that, it can be used to increase efficiency of autonomous robots. The algorithm has potential to be adopted on a significant scale due to its significantly high potential once it is commercialized.

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3. INNOVATIVE APPLICATION SECTOR FOR 3D PRINTING TECHNOLOGY

3D printing technology has proved to have much potential in terms of creating innovative and expanding applications in various industrial sectors, such as aerospace, automotive, medical, and so on. There has been a significant number of innovations in this regard and researchers around the world are working to increase the application sectors further and to enable 3D printing to be used more in actual manufacturing rather than prototyping. Researchers from the University of California Los Angeles (UCLA) in USA have now created a house using 3D printing technology.

The UCLA researchers have built a prototype of a portable house structure using 3D printing. The dimensions of this micro home are 7 feet (base) by 7 feet (length), and 11 feet (height). If is supposed to weigh approximately four tons. The researchers designed this novel structure as two halves of an enclosed shell; and it said to be one of the largest printed residences created using a 3D printer. This project was funded by the company 3M in the USA. The entire house was created using special sand, which was used as the material for creating the house. The printer used in the process was provided by Voxeljet, a 3D printer manufacturer located in Germany, which is a partner company in this research. In this research, an ultrathin layer of the material was deposited layer upon layer to produce the finished product. Once the printer completed printing the layers, the house was then excavated from the loose sand in the print bed, using brushes, compressed air, and vacuum. According to the researchers, the use of 3D printing has helped them in reducing the material as much as possible. For instance, instead of building a wall out of a large assembly of party comprising of different layers, the wall of this house was printed in one piece comprising of one only material. In order to build a strong wall using a material that is capable of retaining heat, researchers are said to have molded the interior of the walls such that they have pores. These capillary like pores running through the walls are said to assist in heating and cooling. After the house was printed, special sand or glue nanomaterial used for molding was infused into the capillaries thereby reinforcing the structure. Since the researchers have only printed one half of the structure, they are currently working on printing the entire structure at once using the 3D printing technology.

Some of the advantages of this innovation are that it has opened newer applications for the technology in the building sector for printing small individual parts and also the entire structure with minimal loss in materials at a significantly less time. This innovation could be a breakthrough in 3D printing aplications once it is commercialized.

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4. PATENT ANALYSIS OF THERMIT WELDING PROCESS

Thermit welding is a welding process based on a chemical reaction. In this welding process, super-heated molten metal is poured around the joints of materials that are to be welded. The chemical reaction that takes place between the metal oxides and the metal reducing agents usually generates the heat that is required for joining of the material. The most preferred metal oxide used in this welding is iron oxide, and magnesium or aluminum is used as a metal reducing agent. The basis for the thermit process is the strong chemical attraction aluminum has for oxygen. In this welding process, the thermit mixture is first ignited using a burning magnesium ribbon. The temperature of this ignited thermit is about 12000 degrees C. The ignition is started at one place on the mixture, which spreads throughout the entire area of the mixture. Then, aluminum combines with oxygen of the metal oxides, thereby causing the iron particles to be deposited on the portion that is to be welded into a superheated liquid metal.

This type of welding is used in repair work of railway tracks and for manufacturing locomotive frames. It is also used for welding crank shafts. Some of the advantages of thermit welding are that the process does not require any external power source, and it can be used for welding significantly large and heavy parts.

The patents exhibited include those pertaining to the use of microwave radiation for thermite ignition and rusty iron regeneration; a manual thermit welding electrode and preparation; thermit welding of aluminumalloy; and a tubular thermit welding crucible.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Thermite ignition and rusty iron regeneration by localized microwaves	March 1, 2012/ WO 2012120412 A1	Ramot At Tel-Aviv University Ltd.	Eli Jerby, Yehuda MEIR	A method and corresponding devices employ a mixture of at least a metal oxide and a metal which undergoes an exothermic chemical reaction. Microwave radiation is applied to the mixture so as to generate a localized hot spot in the mixture, thereby initiating the exothermic chemical reaction. The use of localized microwave radiation facilitates low power and portable implementations. Devices and techniques for cutting, drilling, welding, material synthesis, generating thrust, and mechanical power and motion are also disclosed.
Method of cooling welded rail section, device for cooling welded rail section, and welded rail joint	March 30, 2010/ EP 2415885 A1	Nippon Steel Corporation	Katsuya Iwano, Kenichi Karimine, Seiji Sugiyama, Masaharu Ueda	The invention provides a method of cooling a rail weld zone. The method includes a first rail web portion cooling process of cooling a rail web portion cooling region of the rail weld zone in a part of a temperature range until the completion of transformation from austenite to pearlite, a second rail web portion cooling process of cooling the rail web portion cooling region after the entire rail web portion of the rail weld zone is transformed to pearlite, a foot portion cooling process of cooling a foot portion of the rail weld zone, and a head portion cooling process of cooling a head portion of the rail weld zone. When cooling time of the first and second rail web portion cooling processes is t minute, a k value satisfies an expression represented as -0.1t+0.63≤k≤-0.1t+2.33.
Exothermic mixture for welding containing aluminium, calcium silicide casi2 and transition metal oxides.	October 23, 2009 / EP 2362816 A2	Tubefuse Applications V.O.F	Wayne Rudd, Hu Chun Yi	An exothermic reaction mixture for joining metallic components includes at least one transition metal oxide and, as fuel, a mixture of aluminium and calcium suicide, wherein the molar ratio of aluminium to calcium suicide is from 16:1 to 0.25:1. Methods of preparing the exothermic reaction mixtures and for using them in welding applications are also described.
Manual thermit welding electrode and preparation and using methods thereof	November 20, 2008/ CN 101444876A	Tsinghua University	Yuan Xuan one, Zhancheng Bin, Chen Kexin	The invention discloses a manual thermit welding electrode and preparation and using method thereof which belong to the technical field of welding. A welding compound of the welding electrode comprises a thermit, a slag forming constituent and an alloying agent. Raw materials are weighed according to the proportion and arranged in a ball mill, a grinding ball and a milling medium are added, and the welding compound is obtained by drying after wet grinding; the welding compound is filled in a cylinder which is made of paper, a lead wire is arranged at one end of the cylinder, and the other endis sealed by a plastic plug, thereby forming the thermit welding electrode; the welding electrode is arranged in a sleeve which is made of paper and sealed for preservation. When in use, the sleeve is fixed on the plug at the back end of the welding electrode, the sleeve is held by a hand, and the lead wire at the front end of the welding electrode is ignited, and then the manual welding or cutting operation can be carried out. The welding electrode is small, lightweight and portable, the welding and the cutting operations are simple, rapid and safe, the welding and the cutting operations canbe carried out anytime and anywhere, and the welding electrode can be applied in the welding and the cutting of steels, stainless steels or copper alloy materials.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Aluminothermy welding method of aluminium alloy	August 18, 2008/ CN 101347868 B	Jiangyin Tungda Institute	Li-Hua Liu, Zhang Lei, Zhu Zongguo, Li Jifeng, Tang Sau, Tan Dian-long, GUO Qiang, Chen Wei, Ma Xiangping	The invention relates to a thermit welding method of aluminium alloy, which comprises the following steps: preparing a thermit welding agent; placing the thermit welding agent in a crucible; embeddinga TiC igniter into the thermit welding agent; exposing a part; igniting the exposed part; igniting the thermit welding agent in the crucible for thermit reaction; placing the solid aluminium alloy into the surface of reactants in the crucible immediately after the reaction is finished; using the residual heat to melt the solid aluminium alloy and obtaining the liquid aluminium alloy melt; preheating fractures of the aluminium alloy parts to be welded to the temperature of 390-410 DEG C when the former step is carried out; directly casting the aluminium alloy melt to the position of the fracture of the processed aluminium alloy parts; carrying out the densification processing by striking and extruding the welding seam when the metal to be seamed is just solidified and realizing the welding; and clearing weld flash by hands when the temperature is high. The thermit welding method of the invention is applicable to emergent and fast welding and repairing of aluminium alloy armor plates and aluminium alloy parts of armored equipment in battlefields and is also applicable to emergent welding and repairing of aluminium alloy parts of civilian vehicles or other machines in field working.
Self-contained keyhole weld fitting and method of use	April 29, 2008/ CA 2680788 A1	Brian S. Shaw, Tdw Delaware, Inc.	Brian S. Shaw	The present invention is generally directed toward a method for attaching a self-contained keyhole weld fitting and apparatus. More specifically, the present invention provides an improved fitting and method of use providing a branch outlet which can be physically and sealably secured to an underground pipe while causing less disturbance to the earth above the pipe than using a traditional fitting and excavation.
Crucible for melting a thermit material having a glass or metal layer; thermit welding device with such crucible	December 21, 2007/ WO 2008077957 A1	Fci Connectors Singapore Pte L, Framatome Connectors Int, Funamizu Daisuke	Funamizu Daisuke	The thermit welding device (1) of the present invention comprises: a tubular thermit welding crucible (3) having a bottom portion provided with a through portion (6) to an exterior, and having a glass layer or metal layer formed on an inner tubular surface; and a body portion comprising a cavity portion (10) forming a welding portion, and a passageway (9, 11) communicating with said through portion (6) at one opening portion and communicating with said cavity portion (10) at another opening portion.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Thermite welding tool, crucible and thermite welding methods	July 31, 2007/ WO 2008014982 A1	Fci Connectors Sngapore Pte Lt	Daisuke Funamizu, Hideki Nishijima, Kazumi Wada	The present application relates to a thermite welding method comprising a step of inserting a welding lug into a through hole (9) of a thermite tool or crucible (2) and positioning at least a portion (10) of the welding lug inside a hollow portion (8) with a predetermined spacing from the base metal surface; a step of sealing the aperture portion of the hollow portion (8) by the surface of the base metal; a step of pouring melted thermite into the hollow portion (8) to form a welded portion; and a step of destroying at least the portion (6) between the welding lug and the surface of the base metal in the crucible (13) or the welding tool (1). The invention also provides a welding tool (1) and a crucible (2) for performing this method. The invention achieves an increase in the welding area between the surface of the base metal and the welding lug in thermite welding.
Mould for thermit welding of railway tracks in which at least one is worn, the mould presenting parts protected by compressible material and non protected machinable parts	May 22, 2007/ EP 1862250 B1	Railtech International	Frédéric DELCROIX	This present invention concerns a mold for the aluminothermic welding of railway rails. The compressible lining (58) used to seal the molding die in relation to leakages of the weld metal in the liquid state is limited to the parts of the contact surfaces (52) of the parts (19) of the mold on the rails to be welded, corresponding to the bottom, the sides and the top of the foot, to the sides of the web and below the head. The rigid refractory material of the parts (19) is exposed in the parts (67, 71) of the contact surfaces corresponding to the sides and the top of the head, and suitable to be removed selectively from the latter. This makes it easy to adapt the mold to rails with different degrees of wear.
Deposit metal welding method	May 10, 2002/ US 6805276 B2	Eci	Kazumi Wada	To prevent decreases in fatigue strength of a base material by relieving the residual stress of a weld. A method for welding a deposit metal to a base material with reduced residual stress, comprising a step of welding a deposit metal to a base material; and a step of plastically deforming into a recess, an area on the surface of the base material around a peripheral portion of the deposit metal. The invention is also directed to a welded block joint between a wire and a base material, characterized by comprising a deposit metal receiving an end portion of the wire and welded to the base material, wherein an area which is plastically deformed into a recess is formed on the base material surface at a peripheral portion of the deposit metal.

Exhibit 1 depicts patents related to thermit welding process.

Picture Credit: Frost & Sullivan

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