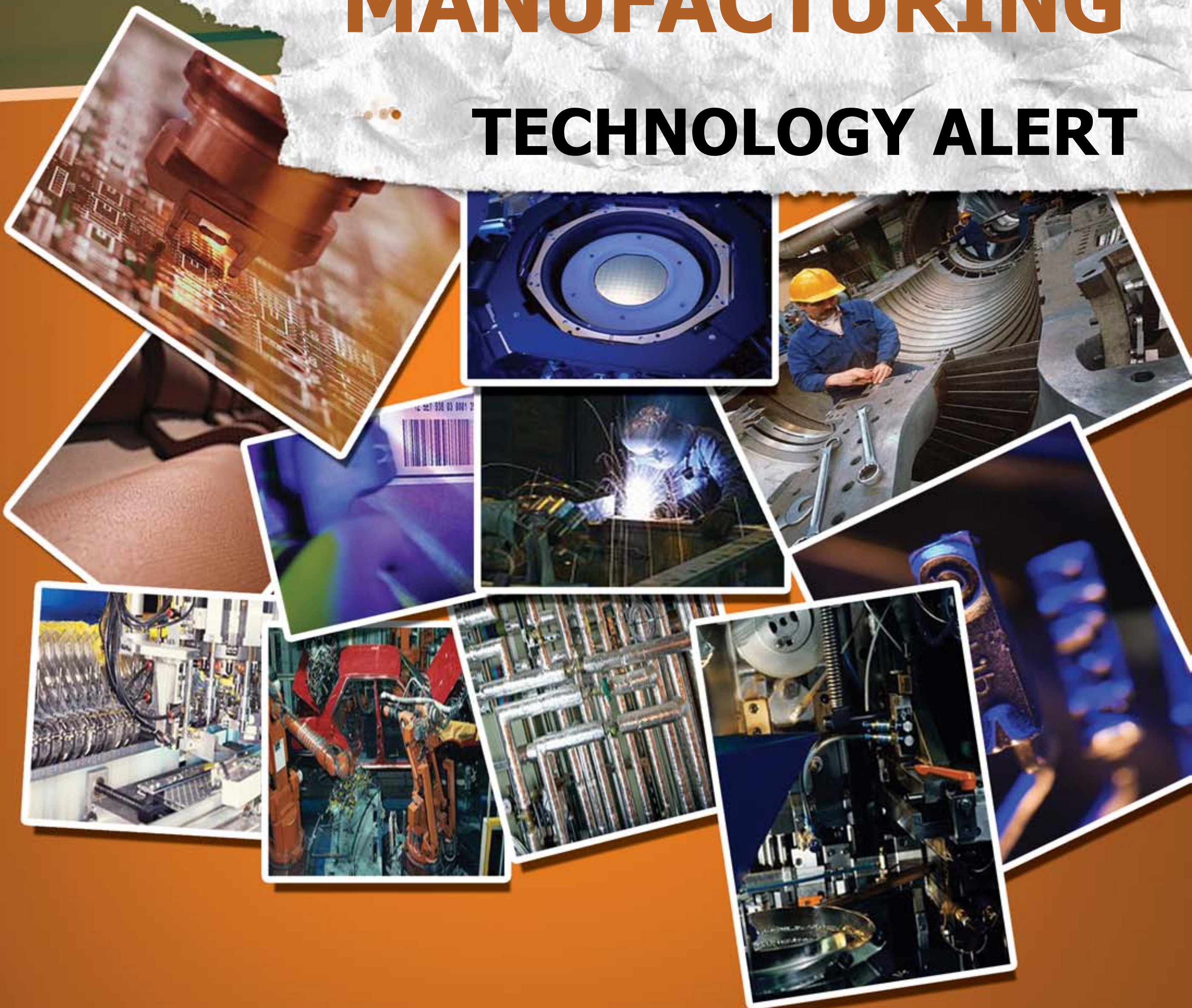
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



10th April 2015

1. COLLABORATIVE ROBOTS FOR INDUSTRIAL APPLICATIONS

Collaborative robots are finding opportunities in manufacturing and automation applications. However, one of the major challenges associated with these robots is that they cannot always be used for high precision tasks. While collaborative robots have facilitated high performance automation and interactive user experience, they still are not used for a wide range of adaptive tasks. Another challenge is that they may not be effectively used for a wide range of tasks, while maintaining the requisite critical flexibility and safety. Many research and developmental efforts across the globe are focused on extending the applications of collaborative robots.

One such effort has resulted in the development of a flexible collaborative robot by Rethink Robotics, USA. The robot, commercialized under the name, Sawyer™, is a single-arm, high-performance robot. Mainly intended for machine tending, circuit board testing, and other precise tasks, the developed robot can be used in automation tasks for which common industrial robots are not fit, as well as for precise repetitive tasks.

The lightweight nature of the robot helps in easy maneuverability in tight spaces. The robot also features a 4kg (8.8 lb) payload, with around 7 degrees of freedom and a 1-meter reach. One of the distinctive features of the robot is that it possesses high-resolution force sensing embedded at each joint. This helps in compliant motion control, enabling Sawyer to “feel” its way through obstacles and fixtures in machines and allows it to function in semi-structured environments. This feature of adaptive precision can be considered unique in robotics industry. Furthermore, elastic actuators used in Sawyer use S-shaped springs made of titanium. Sawyer's arm was made smaller, due to the spring design and having cables run through the joint).

The robot also possesses an embedded vision system, including a camera in its head; this facilitates easy performance of tasks that require a wide view. It is also equipped with a Cognex camera with a built-in light source for precision vision applications. This also facilitates the Robot Positioning System for dynamic re-orientation and can help in supporting advanced features and upgrades, such as, barcode scanning, and object recognition, over a period of time. The robot runs on the ROS-based software platform called Intera and features an interactive control system that will help in programming the robot, only once, for effective operations.

The company has partnered with Jabil, an electronics product company, for field testing and early adoption of the developed robot. The company believes that Sawyer can help in leveraging the best of both humans and machines to optimize productivity. The robot has been undergoing field testing in North America, Europe, China, and Japan.. Sawyer is slated for limited availability release during this summer, and will be targeted for general customer availability later in 2015.

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2. NOVEL METHOD TO PRODUCE MORE EFFICIENT THERMOELECTRIC MATERIALS

Since the discovery of the thermoelectric effect, there has been key improvement in electricity generation and distribution, in terms of efficiency and in harnessing heat. Over the years, many thermoelectric materials and processes have been developed to efficiently convert heat to electricity, and the research for achieving higher efficiency in new thermoelectric (TE) materials and their production methods still takes the center stage.

The initial foundation for development of TE devices was laid in 1834, when Jean Charles Athanase Peltier, a French physicist, found out an essential concept for TE temperature control. Since then, TE devices are known as Peltier devices. Although there has been a constant evolution of TE devices, their efficiency is less in comparison with classic compressor/ evaporation cooling.

During 1960s, alloys of bismuth telluride (Bi_2Te_3) or antimony telluride (Sb_2Te_3) were used to make Peltier devices. These devices had peak efficiency (zT) of 1.1. The alloy technology has seen cumulative growth since then for application in Peltier devices.

A research team consisting of members from research institutes in South Korea and USA has established a new production method for producing an advanced alloy to be used in thermoelectric devices. The new method is scalable and produces thermoelectric materials two times more efficient than the currently available materials. This new improved efficiency promises an array of new applications in areas such as consumer electronics, refrigeration, and transportation.

This new method of producing highly efficient thermoelectric materials was developed by researchers from the IBS Center for Integrated Nanostructure Physics, Samsung Advanced Institute of Technology, the department of nano applied engineering at Kangwon National University, the department of energy science at Sungkyunkwan University, all from South Korea, and the materials science department at the California Institute of Technology, USA.

The metals used in making TE alloys usually have extremely high melting points, which makes it difficult to create alloys by melting the metals. Instead, small metal granules are joined together using pressure by a process known as sintering. The research team used a similar process to create an alloy of antimony, bismuth, and telluride. The team used a specialized sintering process called liquid-flow assisted sintering to create the alloy (Bi0.5Sb1.5 Te3) and the constituent metal granules were held together by melted tellurium.

Normally, when Bi0.5Sb1.5 Te3 is fused using traditional sintering technique, the joints between the metal granules, known as grain boundaries, are coarse and bulky and lower the alloy’s thermal and electrical conductivity. However, the novel liquid-phase sintering technique renders organized and coordinated grain boundaries. Interestingly, the new aligned grain boundaries or dislocation array, as the researchers term it, largely increased the thermoelectric conversion efficiency by reducing the thermal conduction in the alloy.

Efficiency testing of the Bi0.5Sb1.5 Te3 alloy was conducted and overwhelming results were observed. The efficiency (zT) was nearly double that of the industry standard and reached 2.01 at 320K. Similarly, compelling results were observed when Bi0.5Sb1.5 Te3 was used in Peltier cooler, where the alloy sustained a change in temperature of 81K at 300K (26.85 degrees C).

The increasing usage of electric vehicles, smart devices, and personal electronic items demands more efficient systems equipped with self-power generating and competent cooling mechanisms. This new process to produce TE materials with greater efficiency can open up possibilities to develop more efficient TE devices. Also, when this process is scaled up, the traditional refrigeration systems could be easily replaced by Peltier cooling devices that are more efficient and robust.

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3. INNOVATIVE PROCESS TO PRODUCE LESS EXPENSIVE GALLIUM ARSENIDE ELECTRONIC DEVICES

Although many semiconductors have been developed and used since the discovery of silicon, such devices continue to take center stage for various reasons. One of the main reasons for this is that silicon is available in abundance, which makes it inexpensive and feasible for commercial mass production of electronics. But, silicon has shortcomings in certain niche application areas where other semiconductor materials become prominent. In certain applications, gallium arsenide is preferred for its unique capabilities and is far more superior in efficiency than silicon. In solar cells for instance, gallium arsenide gives a greater efficiency as its ability to convert light into electricity is much higher than that of silicon'. The exclusive properties of gallium arsenide explain its cost, which is generally 1000 times that of silicon. Hence, its usage tends to be restricted to specialized applications. Using gallium arsenide as a substitute for silicon could help change the face of electronics by creating a class of electronic devices superior in performance than the existing ones.

With the aim of creating less expensive and highly-efficient electronics, a research team from Stanford University has devised a manufacturing process to produce gallium arsenide electronic devices, which will drastically bring down the cost of such devices.

The circuit manufacturing process, as described by the researchers, begins by molding the semiconductor into a flat and round-platter, usually called 'wafer' by the electronic manufacturers. Then, electronic devices are created on top of the wafer for various purposes, for example, computer chips, and solar cells. Typically, the circuit-on-wafer is created by flowing gallium arsenide along with other materials on the wafer and condensing them on the wafer.

The wafer used for creating the circuit is only a support. The electronics is usually the circuit layer that is formed on the expensive wafer. Hence, reusing the gallium arsenide wafer would reduce the cost of circuits made on them. In order to reuse the wafer, the research team made several additions to the manufacturing process.

In the new process, the wafer is coated with a layer of disposable material. Then, the circuit of gallium arsenide is grown on top of the disposable layer using the typical process of depositing gas. Once the circuit is formed, the disposable layer is eliminated using laser that leaves the circuitry behind. Later, the circuit is mounted on a stronger support and the gallium arsenide wafer is prepared for making the next batch of circuits by cleaning its surface.

The research team reckons that this new process of reusing the wafer would curtail the prices of gallium arsenide circuits to 50 to 100 times than that of silicon. This value is significantly less expensive than the existing cost. This will attract more interest for further research in gallium arsenide electronics.

Silicon became an inevitable choice for the electronics industry, in large part, because it is available at an inexpensive cost. The cost of silicon was not just driven by its abundant availability but also by the competition among various electronics manufacturers, who wanted to capture the electronics market. This new process of producing less expensive gallium arsenide electronics will pave way for more research and development in this space. Clearly, gallium arsenide electronics has more dominance in terms of performance and efficiency, especially in solar energy generation sector.

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4. PATENT ANALYSIS OF SINTERING TECHNOLOGIES

Sintering is a process by which materials are joined or compacted to form a solid mass by heating the materials. Usually, in sintering, materials such plastics, metals, and ceramic are taken in powdered form. Generally, the materials are heated in temperatures less than their melting points with or without applied pressure. Sintering, in comparison to many other joining techniques, has many advantages. Since the materials are taken in powder form, the joints are usually less porous. Also, sintering boosts some properties of the final product such as its strength, thermal and electrical conductivity, ductility, and so on. This process is highly desired in ceramic manufacturing. With advances in technology, sintering of various forms has been developed, such as, electric current assisted sintering, spark plasma sintering, pressure-less sintering and many more.

On-going research in the sintering domain seems to be focused more toward ceramic sintering. A careful look at the latest developments and patents in sintering in 2015--from January 2015 to March 2015--reveals that new sintering methods are invented to join new materials, particularly in the ceramics industry. The patents also reveal that more intricate techniques are being incorporated into sintering technology to achieve higher precision in the sintered product.

Indicative of key trends, a patent assigned to Fujian Jiamei Group Corporation,Sintering Process For Ceramic Sheets (WO/2015/043388), pertains to a new sintering process for ceramic sheets involving controlled kiln temperature. A patent assigned to Nitto Denko Corp., Method and Apparatus For Sintering Flat Ceramics (EP/2838867), refers to a process and apparatus for sintering flat ceramics using a mesh or lattice. Another interesting invention is shown in a patent assigned to WDT Wolz Dental Technik GMBH, Sintered Insert For A Sintering Furnace For The Oxygen-Free Sintering of Metal or Ceramic Material (EP/2844412), pertains to a method of sintering metal or ceramic material, particularly for use in dental technology.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
SINTERING PROCESS FOR CERAMIC SHEETS	April 02, 2015 / WO/2015/043388	FUJIAN JIAMEI GROUP CORPORATION	CHEN, Zhihan	Disclosed is a sintering process for ceramic sheet. A blank body after biscuit firing and glazing is placed in a kiln, wherein the temperature of the kiln is controlled such that: when the kiln temperature is 100-400°C, the temperature rise duration is 1-2 hours; when the kiln temperature is 400-900°C, the temperature rise duration is 2-3 hours; when the kiln temperature is 900-1100°C, the temperature rise duration must reach 3 hours or more; when the kiln temperature is 1100-1350°C, the temperature rise duration is controlled to be 3-4 hours; after the temperature reaches 1350°C, heat-preservation cooling is conducted; when the temperature drops to 1230-1270°C, the temperature is raised again to 1290-1310°C; when the temperature drops again to 880-920°C, the kiln cover is opened for cooling, and the finished product is taken out.
TECHNOLOGICAL PROCESS FOR FLEXIBLE SINTERING OF RARE EARTH PERMANENTLY MAGNETIC ALLOY AND APPARATUS THEREFOR	March 25, 2015/ EP / 2851144	SHENYANG GENERAL MAGNETIC CO LTD	SUN BAOYU	A method for flexibly sintering rare earth permanent magnetic alloy comprises: (1) weighing fine powder of rare earth permanent magnetic alloy, loading the fine powder in moulds, and orientedly compacting the fine powder in a press machine and in inert atmosphere to obtain blanks and loading the blanks into charging boxes; (2) after air between the second conveying vehicle and the first isolating valve of the glove box is replaced with inert gas, opening the two isolating valves connected with each other; wherein after a first rolling wheel transmission in the second conveying vehicle transfers the charging tray into the first chamber of the glove box, the two isolating valves are closed, and the second conveying vehicle leaves; (3) after a first conveying vehicle is coupled with a third isolating valve at an end of the second chamber, locking two matching flanges of the two isolating valves tightly; (4) after the first conveying vehicle is coupled with an isolating valve of a sintering furnace, locking matching flanges tightly; and (5) after the sintering furnace is evacuated to a vacuum degree more than 50Pa, or the sintering furnace is filled with protective gas, processing the blanks with heating and heat preservation according to a preset process curve; wherein the blanks are sintered at a highest temperature of 1200°C. The present invention significantly increases performance of magnets.
METAL SINTERING FILM COMPOSITIONS	March 12, 2015/ WO/2015/034579	HENKEL IP & HOLDING GMBH	RECTOR, Louis P.	A sintering film comprising one or more metals, one or more metal alloys, or blends of one or more metals and one or more metal alloys, is prepared optionally using a solid or semi-solid organic binder. The organic binder can have fluxing functionality; the organic binder can be one that will partially or completely decompose upon sintering of the metal or metal alloy in the composition. In one embodiment, the sintering film is provided on an end use substrate, such as a silicon die or wafer, or a metal circuit board or foil, or the sintering film is provided on a carrier, such as a metal mesh. Preparation is accomplished by dispersing the metal or metal alloy in a suitable solvent, with or without a binder, and exposing the composition to high temperature to evaporate off the solvent and partially sinter the metal or metal alloy.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
SINTERED INSERT FOR A SINTERING FURNACE FOR THE OXYGEN-FREE SINTERING OF METAL OR CERAMIC MATERIAL	March 11, 2015/ EP / 2844412	WDT WOLZ DENTAL TECHNIK GMBH	WOLZ STEFAN	The invention relates to a method for sintering metal and/or ceramic material in a sintering furnace, in particular for use in the field of dental technology, in which a connection of a sintering space of a sintered insert arranged in the sintering furnace is created by means of one or a plurality of channels or pipes to the surrounding area outside of the sintering furnace, wherein alternately shielding gas is introduced into the sintering space and shielding gas with possible impurities, e.g., oxygen, is extracted by means of the connection.
SINTERING DEVICE AND SINTERING METHOD USING INDUCTION HEATING	March 11, 2015/ EP / 2845914	POSCO	KANG YOUNG JU	Disclosed are a sintering device and method using induction heating capable of inducing heating of highly conductive materials included in raw ore through magnetic induction of an induction coil to heat the raw ore. The sintering device using induction heating inductively heats raw ores to produce sintered ores, and includes an induction case and a heating inductor which is mounted in the induction case and induces the heating of the raw ores that is housed in or passes through the induction case through magnetic induction.
METHOD AND APPARATUS FOR SINTERING FLAT CERAMICS	February 25, 2015/ EP / 2838867	NITTO DENKO CORP	MIYAGAWA HIROAKI	A method and apparatus for sintering flat ceramics using a mesh or lattice is described herein.
SINTERING FURNACE WITH A GAS REMOVAL DEVICE	February 19, 2015/ US / 20150050610	GKN Sinter Metal Holdings GmbH	Ernst Eberhard	A sintering furnace with a first zone, in particular a burn-off zone, and a second zone, in particular a sintering zone, and also a transitional zone arranged between the first zone and the second zone. The sintering furnace has at least one transporting mechanism for transporting bodies to be sintered on a transporting area. With this transporting mechanism, the bodies to be sintered can be transported from the first zone and through the transitional zone to the second zone. The sintering furnace also has at least one gas removal device with at least one gas removal device opening. Here, the gas removal device opening is at least partially arranged in the region of the transitional zone. Furthermore, a method by access of which gases can be removed from a sintering furnace is claimed.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
DIELECTRIC COMPOSITION FOR LOW-TEMPERATURE SINTERING, MULTILAYER CERAMIC ELECTRONIC COMPONENT INCLUDING THE SAME, AND METHOD OF MANUFACTURING MULTILAYER CERAMIC ELECTRONIC COMPONENT	January 29, 2015/ US/ 20150029637	Samsung Electro-Mechanics Co., Ltd.	LIM Jong Bong	There is provided a dielectric composition for low-temperature sintering including $BaTiO_3$ as a main ingredient, and xB_2O_3-(1-x)BaOas an accessory ingredient, wherein x ranges from 0.25 to 0.8, and the content of the accessory ingredient ranges from 0.1 to 2.00 mol %, based on 100 mol % of the main ingredient.
CONDUCTIVE FILM FORMING METHOD AND SINTERING PROMOTER	January 29, 2015/ US/ 20150030784	ISHIHARA CHEMICAL CO., LTD.	Kawato Yuichi	In a conductive film forming method using photo sintering, a conductive film having low electric resistance is easily formed. The conductive film forming method is a method in which a conductive film is formed using photo sintering. This method includes the steps of forming a layer made of a sintering promoter on a substrate, forming a liquid film made of a copper particulate dispersion on the layer of the sintering promoter, drying the liquid film to form a copper particulate layer, and subjecting the copper particulate layer to photo sintering. The sintering promoter is a compound which removes copper oxide from metallic copper. Thereby, the sintering promoter removes a surface oxide film of copper particulates in photo sintering.
CONTROLLING OF SINTERING KINETICS OF OXIDE CERAMICS	January 29, 2015/ WO/2015/011079	IVOCLAR VIVADENT AG	ROTHBRUST, Frank	The invention relates to multi-layer oxide ceramic bodies and in particular to presintered multi-layer oxide ceramic blanks and oxide ceramic green bodies suitable for dental applications. These bodies can be thermally densified by further sintering without distortion and are thus particularly suitable for the manufacture of dental restorations. The invention also relates to a process for the manufacture of such multi-layer oxide ceramic bodies as well as to a process for the manufacture of dental restorations using the multi-layer oxide ceramic bodies.

Exhibit 1 illustrates patents related to sintering technologies.

Picture Credit: Frost & Sullivan

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