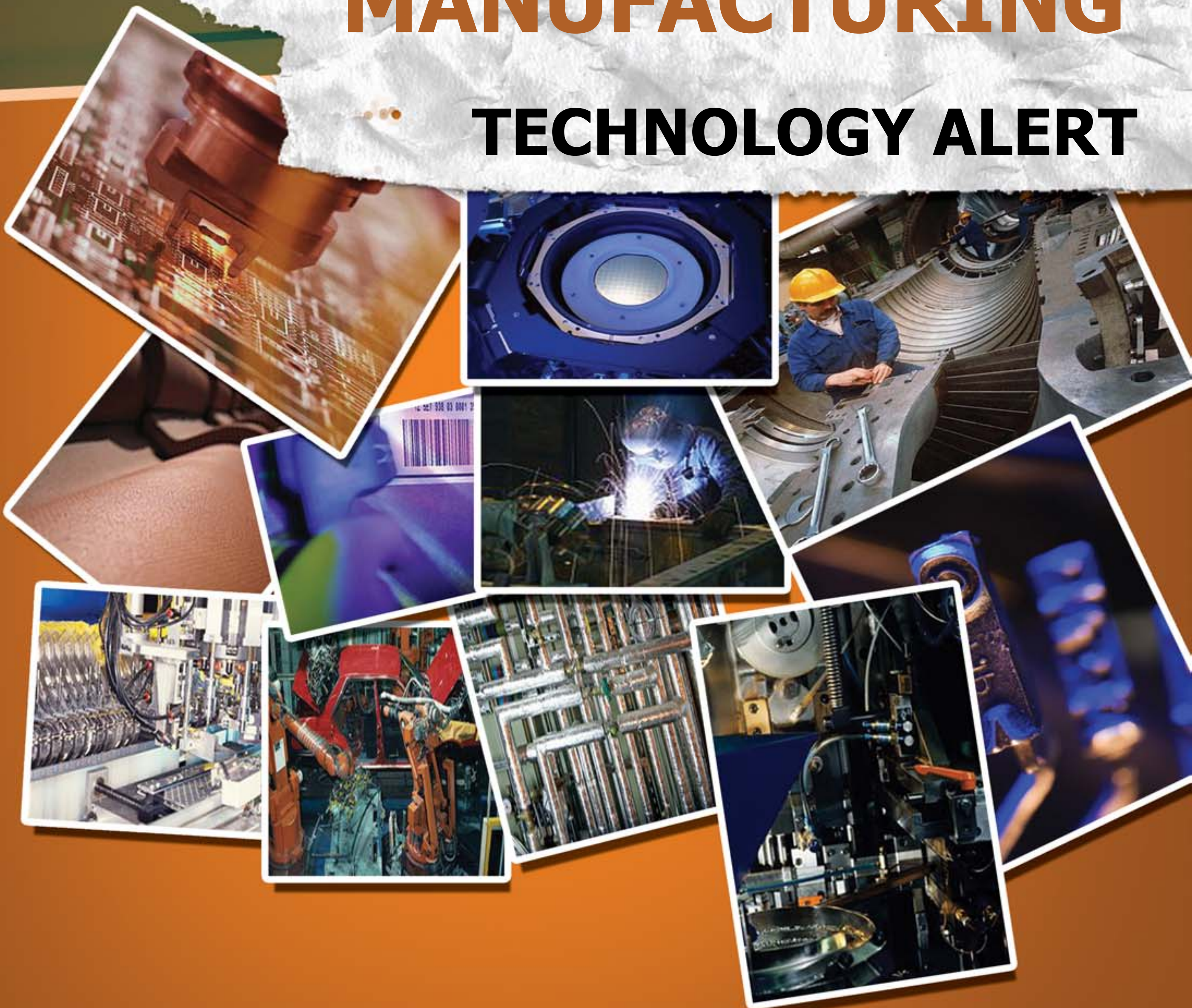
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



30th January 2015

1. SWARM ROBOTS THAT FUNCTION WITHOUT MEMORY OR PROCESSING POWER

A novel way of manufacturing a swarm of hundred or thousand tiny robots that are capable of carrying out various tasks in a group without using any memory or processing power has been developed by engineers at the University of Sheffield, UK.

The engineering team from the Sheffield Centre for Robotics (ScentRo) in the Engineering Faculty of the University has succeeded in programming significantly small and simple robots that have the potential to form a dense cluster without the help of complex computer algorithms. The operation of these simple swarm robots is very similar to the operation of a swarm of bees or birds that work together for carrying out various tasks. This innovation will help in the development of future swarm robots that could be used for different applications in the agricultural industry to enable precise farming techniques using simple and less expensive robots. In one of the experiments, a group of 40 robots was programmed to perform the task of clustering; and the developers of these robots believed that by using computer simulations, the number can be expanded to accommodate thousands of robots. Each of the robots is equipped with only one sensor which enables the robots to see another robot that is in front of them. Based on whether or not they can see another robot in front of them, the robots either rotate on the spot or move around in a circle until they see another robot. By doing so, the robots would be able to gradually form and maintain a cluster formation for performing tasks. According to the developers, the uniqueness of the robots is in the simplicity with respect to architecture and working. For instance, since these robots do not require any memory, the need for performing any calculations is completely eliminated and also it requires significantly less information about the environment. Swarm robots developed previosuly tended to require complex programming, making it difficult to decrease the size of the robots.

With this innovation from the engineers from Sheffield University, the development of nanoscale robots has been made possible. One of the other unique features of thesel robots is that, even if some of the information is corrupted, the other robots in the swarm would be able to work together and complete the task. Another potential application for the robots is that they can be programed to monitor the levels of pollution in the environment. They can also be used for performing tasks in places that are considered dangerous for humans. Moreover, due to their small size, the robots can be employed in the healthcare industry for diagnosis of vascular networks in a noninvasive manner.

The swarm robots have a large number of advantages, such as significantly small size, simple architecture and working principle thereby making them less expensive. The above-mentioned advantages and features would make these robots suitable for a wide range of application areas in different industrial sectors.

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2. NOVEL DEVELOPMENT IN THE FIELD OF MICROROBOTS

Small or tiny robots, which are also called microrobots, are being developed for a wide range of range applications in various industrial sectors. For instance, small microrobotic modules could be used for lifting parts and components from a storage space and transporting them to a different location. Researchers have now developed novel small reconfigurable microrobotic modules that are connected to each other and transform themselves into any shape and size. This enables the robot to connect them together and change the shape whenever required.

This microrobot, named Roombot, has been developed by Biorobotics Laboratory (BioRob) at École polytechnique fédérale de Lausanne (EPFL), Switzerland. The self-assembling microrobots can be banded together to make stationary objects, such as boxes, furniture, and walls. Roombots attach with each other to form the

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desired shapes. The idea behind this innovation is creating self-assembling robots that can be used in a wide range of ways. For instance, when there is a need to transport a set of parts and components on a factory floor, these microrobots can be made to transform into storage boxes and then transport to a different location on their own. The researchers were able to make the Roombots move freely and ensure multi-functionality in these robots. The modules that are attached to the microrobots detach from the pile while forming structures of two or more modules. At this point of the research, the microrobots are capable of moving around in a room with specific grid locations. The researchers are currently working on expanding this capability to larger structures with reduced energy consumption and impact with the ground surface. Another key capability of Roombots is that they can climb walls or a step when the surface is fitted with connector plates. A single module of the microrobot would be able to autonomously reach any position on a plane and pass over a concave edge. When there is a need to go over a convex edge, two modules will be required. One of the key advantages of this microrobot is that the module in the robots can be tightly packed together, thereby making transportation easy. Moreover, they can be reconfigured to any type of structure with ease. The researchers are working on increasing the ability of the microrobots to attach themselves to passive elements for ease of manipulation. Currently, work is in progress for improving the overall robustness and reliability of the Roombots.

Some of the potential application sectors for Roombots are the household and industrial sectors, where they would help improve the overall quality of human life. Innovations such as this can further enhance the adoption rate and a increase the application sectors for microrobots.

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3. TECHNIQUE TO IMPROVE ENERGY EFFICIENCY OF ROBOTS

Robots are currently being used in a wide range of emergency and rescue operations. The use of robots for these applications has increased as they significantly decrease the potential threats for humans while performing dangerous tasks. One of the key challenges surrounding robots that are being used for rescue operations is energy efficiency. Research efforts have been focused on finding a novel technology to address the above-mentioned challenge.

Researchers from the Sandia National Laboratories, USA, are currently working on developing a technique that is expected to significantly improve the endurance of legged robots, thereby enabling them to work for long periods of time. This project by Sandia National Laboratories has been funded by the Defense Advanced Research Projects Agency (DARPA), USA. The researchers are also developing a robot prototype named Walking Anthropomorphic Novelty Driven Efficient Robot for Emergency Response (WANDERER) to demonstrate the working of their novel technique. This innovative robot enables increased and optimized energy efficiency. In the robot prototype, the researchers have used energy efficient actuators which are attached to the joints of the robots. The actuator system employs efficient brushless direct current (DC) motors with significantly high torque-to-weight ratios, efficient low ratio transmissions, and specially designed passive mechanisms that are customized for each of the robots' joints in order to ensure that there is high energy efficiency.

In addition to the above-mentioned elements, the researchers have also included a set of support elements, such as springs and variable transmissions in order to keep the operation of the motors more efficient by reducing losses. As the electric motors are seen to be inefficient when large torque is provided at low speed, the supports that have been provided in WADERER help to reduce the load on the motor. The support element also enables the robots to self-adjust during behavioral changes. For instance, adjustments could be made to the joints of the robots, thereby optimizing the energy efficiency under various working conditions of the robot. From the various tests conducted by the researchers, it has been found that the robot prototype could be operated with high efficiency and also with significantly reduced noise. According to the researchers, the reduction of noise has helped them to further decrease the loss of energy from the robot. The researchers have also said that the design elements and software used in their robot prototype would be made available to the public, thereby allowing engineers and designers across the globe to make advances in the field of robotics.

The advantage of this novel technique is that it increases the efficiency of robots, thus expanding the application sectors for the robots. This technique has potential to be adopted by a wide range of robotic manufacturers and researchers, making their products and innovations more suitable for varied application sectors.

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4. PATENT ANALYSIS OF THERMOPLASTIC EXTRUSION PROCESS

Thermoplastic extrusion is a process for converting plastic materials from solid to liquid state, thereby reconstituting them to form a finished product. The machine used for carrying out the thermoplastic extrusion process is very similar to that of an injection molding machine. It consists of a motor, which turns the thread to feed the plastic granules into a heater. In this process, the plastic fillets are gravity fed from a hopper into a jacketed screw. When the screw is made to turn about its axis, the plastic pellets are transported and pressurized. After it is pressurized, the molten material is forced through a die that converts it into a specified shape and cross section, thereby producing parts with a wide range of length.

One of the latest patents in the thermoplastic extrusion process, WO 2013135978 A1, is assigned to Algopack. It pertains to a filled thermoplastic material, suitable for injection or extrusion. Illinois Tool Works Inc., has filed a patent (CA 2428455 C) pertaining to thermopalstic polymer extrusion bending. Some of the other key innovators for this manufacturing process include General Electric Company (patent No. EP 0820848 B1, pertaining to fiber reinforced thermoplastic extrusion) and ExxonMobil Chemical Patents Inc. (patent EP 2593287 A1, pertaining to adhesive extrusion for dynamically vulcanized thermoplastic elastomer laminates).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Filled thermoplastic material suitable for injection or extrusion and corresponding production process	September 19, 2013/ WO 2013135978 A1	Algopack	Rémy LUCAS	The invention relates to a filled thermoplastic material capable of being injected or extruded, comprising at least 90% by weight, and preferably at least 97% by weight, of a mixture of a thermoplastic polyolefin, in particular of polypropylene or high-density polyethylene, with a material that forms a filler, and to the production process thereof. According to the invention, said material that forms a filler comprises an alkali metal alginate in a weight proportion of 5% to 15% of the total weight of said material, a filler agent, preferably diatomaceous earth, in a weight proportion of 65% to 80% of the total weight, a gelling agent such as calcium sulphate and a gelling control agent, and is combined with said thermoplastic polyolefin in respective weight proportions of 40 to 150 g per 100 g within said mixture.
Rounded rectangular thermoplastic elastomer (TPE) extrusion particle	July 31, 2013/ CN 203092825 U	Tianjin Jie Xiang Plastic Co., Ltd.	Peng, Jihong Xu	The utility model relates to a rounded rectangular thermoplastic elastomer (TPE) extrusion particle. The particle is of a rounded rectangular structure with four ribs provided with rounded corners, wherein the rounded rectangle is 2-4mm in rectangle length and 2-3mm in height, and the rounded corners of the four ribs are 1-2mm in diameter. According to the extrusion particle, through changing the neck mould of an extruder, the end face of the extrusion particle is is of a rounded rectangle, thus enhancing the thermal stability and the weather fastness of the extrusion particle; and meanwhile, the extrusion particle is simple in structure and convenient to process, and the extrusion particle of a rounded rectangle improves the compression resistance strength of a product.

Adhesive extrusion for dynamically vulcanized thermoplastic elastomer laminates	May 22, 2013/ EP 2593287 A1	ExxonMobil Chemical Patents Inc.	Gregory S. Caraway, Porter C. Shannon, Adriana S. Silva	A coextrusion process for coextruding a thermoplastic elastomer with two outer layers of adhesive to form a film, and a laminate comprising a plurality of layers including an adhesive layer, a sublayer and a barrier layer. The barrier layer comprises a dynamically vulcanized thermoplastic elastomer composition present in one or more plies of the barrier layer. The sublayer comprises a first ply of a first adhesive composition joining the barrier layer and a second ply, and the adhesive layer comprises the second ply, which is vulcanizable with diene-based rubber. The sublayer of the adhesive can be laid down in contact with the relatively hot thermoplastic elastomer to moderate the temperature of the outer layer of the adhesive, whereby the outer layer of the adhesive at least is protected from scorching and can be co-vulcanized with rubber in a tire building process.
Polymeric drug delivery systems and thermoplastic extrusion processes for producing such systems	August 4, 2010/ EP 2211760 A1	Axxia Pharmaceuticals, Llc	Stuart A. Grossman, Albert H. Owens, Wayne C. Pollock	Implants are disclosed for delivery of therapeutic agents such as opioids, and the manufacture and uses of such implants.
Method and apparatus for extrusion of thermoplastic handrail	June 2, 2010/ EP 2190644 A1	EHC Canada, Inc.	Ronald Harold Ball, Alexander Stuart Caunce, Viqar Haider, Andrew Olivier Kenny, Douglas James Weatherall	A method and apparatus for extrusion of an article is provided. A die assembly can apply flows of thermoplastic material to an array of reinforcing cables to form a composite extrusion. A slider fabric can be bonded to one side of the composite extrusion. After exiting the die assembly, the slider fabric can act to support the extrudate as it passes along an elongate mandrel, which can cause the base of the slider fabric to change shape from a flat profile to the final internal profile of the article. The extruded article can then be cooled to solidify the material. The die can include cooling for the slider fabric and means for promoting penetration of the thermoplastic into reinforcing cables.

Thermoplastic polymer extrusion bending	May 1, 2007/ CA 2428455 C	Illinois Tool Works Inc., Arthur S. Goldman, Matthew B. Moyer	Arthur S. Goldman, Matthew B. Moyer	Methods for bending preformed thermoplastic extrusions having at least one cavity comprise filling at least one of the extrusion cavities with polymer foam and curing the foam within the filled cavity. An extrusion is heated to allow plastic deformation and then smoothly bent over a mandrill to impart a desired curved shape. Following cooling to below the extrusion's plastic deformation temperature on the mandrill, smoothly curved extrusions are removed for cooling to room temperature. Cured polymer foam within an extrusion cavity resists distortion of the cavity during the bending process.
A homogenization enhancing thermoplastic foam extrusion screw	March 9, 2005/ EP 1216125 B1	James D. Fogarty	James D. Fogarty	A foam extrusion assembly (10) having a melt region (20) and a heat extraction region (40) which extracts excess heat from a mixture of melted material pellets and blowing agent. The heat extraction region includes an elongate barrel (50) having an inlet (31) and an outlet (44), the inlet receiving the extrusion mixture for passage into the barrel wherein a heat extraction structure disposed with the barrel draws heat therefrom. An extrusion screw (60) is disposed in the barrel and includes a screw flight (64) structured to rotate within the barrel and urge the extrusion mixture towards the outlet of the barrel where a die (44) is disposed in order to form the finished product. The screw flight (64) includes a circulation channel (90) which receives quantities of the extrusion mixture upon rotation of the extrusion screw, thereby circulating the extrusion mixture towards the barrel for more effective and uniform cooling of the extrusion mixture to an extrudable temperature.
Thermoplastic foam extrusion assembly	July 21, 2004/ EP 1438166 A2	James D. Fogarty	James D. Fogarty	A foam extrusion assembly having a melt region which melts material pellets, an agent addition assembly which adds a foaming agent to the pellets, and a mixing assembly which mixes the pellets and the agent with one another. The mixing assembly includes an elongated barrel through which the pellets and the agent are urged from an inlet to an outlet of the barrel. The mixing assembly includes a mixing plug disposed in the barrel passages along a length thereof, the flow passages, which are structured and disposed to receive the pellets and the agent therethrough so as to define a flow path past the mixing plug, each have at

				least one small transverse dimension so as to restrict amounts of the pellets and the agent which enter the flow passage at one time, and are short in length as to minimize a duration of a flow restriciton at the flow passages.
Fiber reinforced thermoplastic extrusion	May 8, 2002/ EP 0820848 B1	General Electric Company	Erich Otto Teutsch	The present invention relates to a process for making an extruded thermoplastic material and having continuous fiber reinforcement and a process for its preparation.
A homogenization enhancing thermoplastic foam extrusion screw	February 15, 2001/ WO 2001010617 A1	James D Fogarty	James D Fogarty	A foam extrusion assembly (10) having a melt region (20) and a heat extraction region (40) which extracts excess heat from a mixture of melted material pellets and blowing agent. The heat extraction region includes an elongate barrel (50) having an inlet (31) and an outlet (44), the inlet receiving the extrusion mixture for passage into the barrel wherein a heat extraction structure disposed with the barrel draws heat therefrom. An extrusion screw (60) is disposed in the barrel and includes a screw flight (64) structured to rotate within the barrel and urge the extrusion mixture towards the outlet of the barrel where a die (44) is disposed in order to form the finished product. The screw flight (64) includes a circulation channel (90) which receives quantities of the extrusion mixture upon rotation of the extrusion screw, thereby circulating the extrusion mixture towards the barrel for more effective and uniform cooling of the extrusion mixture to an extrudable temperature.

Exhibit 1 depicts patents related to the thermoplastic extrusion process.

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