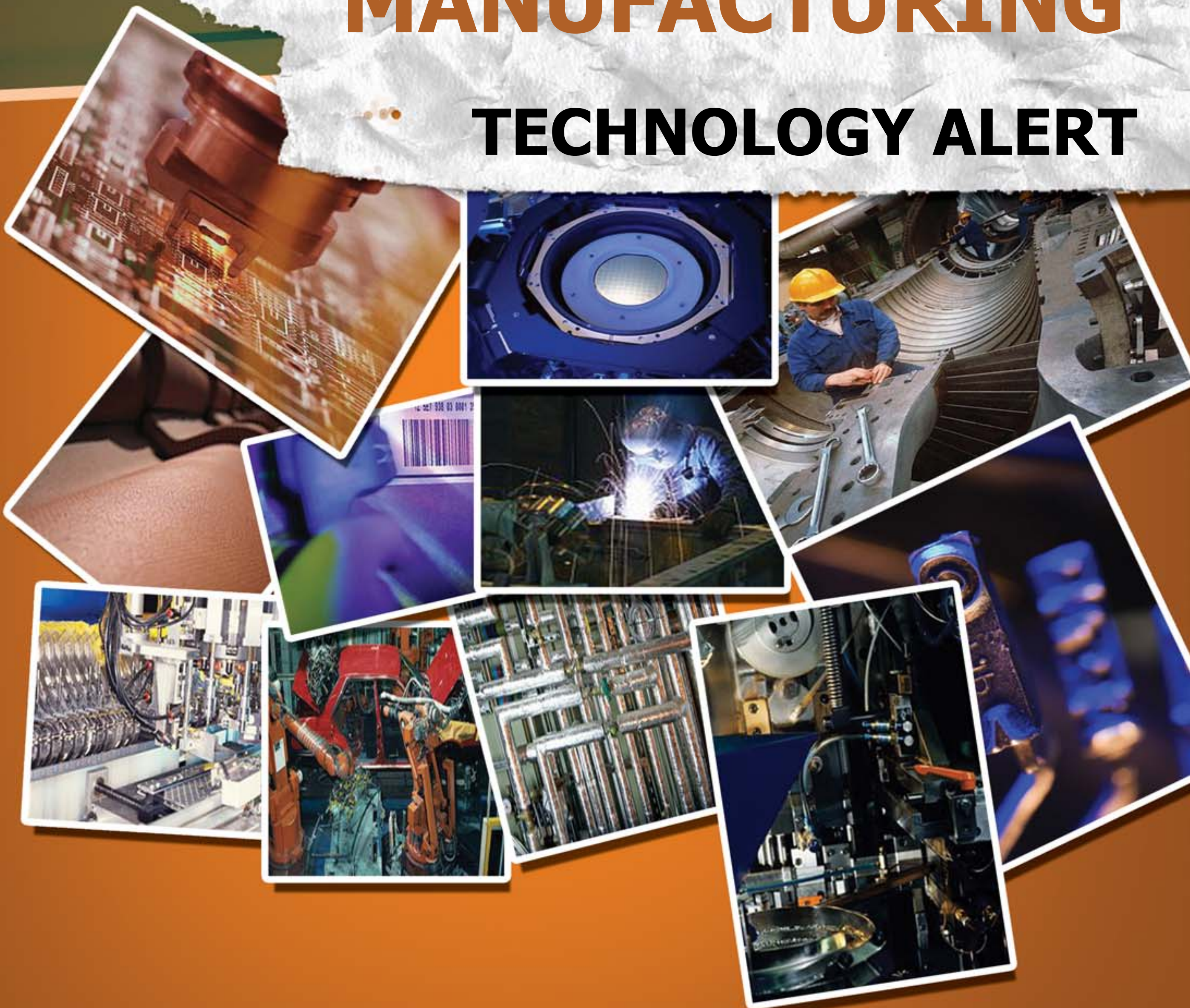
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



24th April 2015

1. 3D PRINTER FOR PRINTING SOFT OBJECTS FROM FABRIC

Three-dimensional (3D) printing technology has been profoundly transforming the manufacturing industry in the recent past. Today, 3D printers can create varied objects of intricate geometries and complex designs from metal, plastic, and rubber. Over time, 3D printing technologies have evolved to incorporate various other materials to produce custom objects. Many research organizations and industry leaders across the globe are trying to develop materials and processes for printing newer objects using different materials.

In an attempt to extend the benefits of 3D printing to create soft objects, a team of researchers from Disney Research Pittsburg and Carnegie Mellon University has developed a 3D printer that can print soft and squeezable objects. This 3D printer produces objects such as soft toys, phone cases, and so on, by layering fabric sheets that are cut by using laser. This printer is capable of producing soft objects of intricate geometries and can include electronic circuitry.

The new layered fabric printer is related to laminated object manufacturing technology. Similar to laminated object manufacturing, where 3D objects are created by layering paper or metal sheets cut into two-dimensional (2D) shapes, the fabric printer uses sheets of fabric cut in 2D fashion. Further, the layered sheets are bonded to make a solid 3D structure. However, unlike the typical laminated object manufacturing, cutting and processing the fabric during printing posed certain challenges, which the researchers had to address.

To address the challenges of fabric processing, an earlier soft 3D printer designed by Disney Research was considered. However, this printer created objects by depositing layers of needle-felted yarn, which is less thick and squeezable than needed for the desired objects. Hence, the design was altered to address these issues and the research team developed a device having two fabrication surfaces.

The layered soft fabric printer has two platforms—an upper platform for cutting, and a lower platform for bonding layers of fabric. The printing process begins with a vacuum device holding the fabric over the upper cutting platform. The vacuum device draws the fabric from a fabric roll. Below the upper cutting platform is a moving laser cutting device. This laser device first cuts the fabric in rectangles and then into desired 2D shape of each layer. In order to support the fabrication process, the remainder of the rectangular fabric is not removed.

After completing the cutting process of each layer, the uncut fabric is released from vacuum by shutting off the vacuum. The cutting platform is lowered and the bonding layer takes control. The bonding layer consists of a heated bonding head and the corners of the rectangle are pressed against previous layers of fabric, similar to ironing clothes. Then, the bonding is done by applying heat-sensitive adhesive on the fabric and pressing against the previous layers.

The process is repeated until the desired object is printed. After completion, the 3D object is revealed by eliminating the surrounding support fabric manually. The research team created a 2.5 inch bunny using this technique. The fabric used for creating the bunny was 2 millimeter thick and a total of 32 layers were used to create it over a time of 2.5 hours. This prototype had visible layers and the researchers explain that layers can be made invisible by using thinner fabrics and more layers. However, creating more layers would require longer turnaround time to produce the object.

The team also created prototype of a starfish embedded with conductive fabric using this printing technique. While this starfish can be used as a touch sensor, another prototype of a mobile phone case with conductive fabric capable of harvesting the phone’s near field communication (NFC) signals to illuminate its LED was also created.

Details: Dr. Jim McCann, Associate Research Scientist, Disney Research, Pittsburgh, 4720 Forbes Avenue Lower Level, Suite 110. Pittsburgh, PA 15213. Phone: +1-412-400-3199. E-mail: jmccann@cs.cmu.edu

2. NOVEL METHOD FOR LARGE-SCALE PRODUCTION OF 2D MATERIALS

Two-dimensional (2D) materials, or single-layered materials, consist of only one layer of atoms or molecules. These materials can have unique properties and have an application opportunities in various fields such as electronics and optoelectronics, sensors, photovoltaics, and medicine, among others.

An excellent example for a two dimensional material is the versatile allotrope of carbon, graphene. In graphene, the carbon atoms are arranged in a pattern similar to honey that renders unique properties. Particularly, graphene's strength and electrical conductivity are better compared to steel. Hence, graphene is attractive for making electronic devices that are much smaller than devices currently available. But, graphene is not a pure semiconductor and requires many processes to make it a semiconductor. Thus, in order to create 2D electrical devices, it is important that the material is suitable to create transistors. This has led scientists to focus on developing materials that are semi-conductor in character and can be made into transistors.

A research team from A*STAR Institute of Material Research and Engineering in Singapore has established a method to produce a two-dimensional semiconductor in a single layer of atomic dimension. The researchers' material of choice is molybdenum disulfide, a material belonging to a clan of materials called transition-metal dichalcogenides.

Dichalcogenides are materials in which for every atom of transition-metals, such as molybdenum or tungsten, two atoms of chalcogenide are present. Common examples of chalcogenides are sulfur, selenium, and tellurium. These materials are widely preferred in two-dimensional electronics for their exclusive electrical properties. This makes dichalcogenides a superior raw material for many electronic applications, although producing these materials on a large-scale has remained a major challenge.

The new process developed by the A*STAR researchers can be adapted in industrial scale for producing large quantities of molybdenum disulfide in the atomic scale. The main drawback of the previously used conventional methods is their restricted usage in applications of commercial importance. Also, the chemical methods used for producing molybdenum disulfide cannot be merged with fabrication. The researchers explained that the new process creates high-quality layers of molybdenum disulfide and it is a single step process. This process is used in creating multi-layers of molybdenum disulfide using magnetron sputtering during the wafer stage of producing electronic devices.

The process began in a vacuum chamber containing sulfur vapor, where a beam of argon ions were discharged at a molybdenum target. When the argon ions hit the molybdenum surface, atoms of molybdenum were released. The molybdenum atoms then reacted with the surrounding sulfur vapor to form molybdenum disulfide. This was later deposited on the surface of desired substrate such as sapphire or silicon by heating the substrate. On subsequent experiments, the researchers figured out that by adjusting the intensity of argon-ion beam or deposition time, they could form multiple layers of molybdenum disulfide on the substrates.

Further, the researchers inspected the quality of the material coating using various techniques such as Raman spectroscopy, atomic force microscopy, X-ray photoelectron spectroscopy, and transmission electron microscopy, which revealed the superior quality of the coatings. Also, a working transistor using this molybdenum disulfide was created to display its electrical properties.

The researchers are now focusing on extending this technique to create 2D materials from other materials. This can not only enable new opportunities in shrinking the already existing electronics, but can also pave the way for developing 2D electronics from many newer materials.

Details: Dr. Shijie Wang, Deputy Head and Senior Scientist II, A*STAR Institute of Materials Research and Engineering, 3, Research Link, Singapore 117602. Phone: +65-6874-8184. E-mail: sj-wangimre.a-star.edu.sg.

3. SCALABLE METHOD FOR ENERGY EFFICIENT MANUFACTURING OF AIRCRAFT PARTS

Advancements in aerospace engineering have vastly changed the air transportation industry in the last two decades. Active research and development activities with funding from several industry leaders and government agencies have led to creation of aircraft that are long-lasting, lightweight, and cost less. Several composite materials, developed over time, have been largely responsible for construction of aircraft parts that are more efficient and weigh less. However, a cost-effective setup for joining or fusing several composite materials has thus far been difficult to achieve.

A group of aerospace engineers from Massachusetts Institute of Technology (MIT) has developed a material and method to fuse composites for aircraft parts that saves enormous energy during the fusing process. The material, a carbon nanotube (CNT) film designed by the group, can fuse composites without requiring heating in ovens at high temperatures. The researchers tested the film by using it to fuse an aircraft component that is made of carbon-fiber. The tests revealed that the composite rendered by the film during the fusing had properties comparable to oven-heated composites. Interestingly, the new method consumed only 1/100th the energy required by conventional industrial ovens to fuse composite materials.

The researchers explained that a four-story oven would normally be required for manufacturing components such as wings and fuselage for aircraft like Airbus A350 or Boeing 787. An oven of this size requires several millions of dollars in investment for creating the infrastructure. But, the new technique developed in the MIT laboratory would take the fusing process out of the oven as it applies heat only to the areas that are being assembled. Also, the CNT films are incredibly lightweight and have width less than human hair, adding insignificant weight to the composites.

The new method was inspired by an observation during a previous experiment the research team was involved in. The experiment was to de-ice airplane wings using CNT films. In the course of the experiment, the CNT film was merged to airplane wings and it was observed that the CNT films heated up and melted the ice when a voltage was applied across the film. This phenomenon intrigued the team to explore the possibilities of using CNT films to create composites.

In the beginning, two types of composite materials usually used in making airplane wings and fuselages were chosen to explore the fusing ability of CNT films. Normally, these materials have 16 layers and are fused in industrial ovens at very high-temperatures.

A square piece of one the composites, Cycom 5320-1, was made, and a CNT film of about the size of postcard was placed between two layers of Cycom. Then, heat was applied to the Cycom layer and the film by connecting electrodes to the CNT film. The CNT film then fused the materials and the research team ascertained the energy used to fuse these composite materials using CNT film. The energy measurement revealed that the new fusing process took only 1/100th the energy that would have been required had the Cycom be fused in an industrial oven. Also, the physical properties of the composites fused in oven were compared with the newly created composite and the properties remained similar.

Some polymer composite materials used in airplane construction have solidifying temperatures of about 750 degrees F. In order to use CNT films to fuse these materials, the ability of the CNT films to withstand higher temperatures was tested by applying more and more voltage across them. It was observed that the films were able to withstand temperatures of about 1000 degrees F. This means that CNT films can be used to fuse any composite used in aerospace engineering.

After discovering this breakthrough method, the researchers are currently working with airplane manufacturers to scale up this process to make large airplane parts. Many industry leaders have already been part of this research by participating in the funding process. Aircraft manufacturers such as Airbus Group, Boeing, Embraer, Lockheed Martin, Saab AB, as well as TohoTenax, a provider of carbon fiber, ANSYS Inc.,a developer and provider of engineering simulation software, have funded this research, along with government agencies—the Air Force Research Laboratory at Wright-Patterson Air Force Base, and the US Army Research Office.

Details: Brian L. Wardle, Associate Professor of Aeronautics and Astronautics, Department of Aeronautics and Astronautics, 33-408, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139. Phone: +1-617-252-1539. E-mail: wardle@mit.edu.

4. PATENT ANALYSIS OF MILLING PROCESS

Milling is type of machining process, which involves cutters that operate on the work piece in rotary fashion and render a precise shape and size for the work piece. Milling is a commonly used machining process in many industries. It is a versatile process and can be used for small units of work pieces as well as for large units and parts that use heavy duty gang milling (two or more milling cutters ganged or mounted on a single arbor in horizontal milling arrangement).

.

Many machine tools can be used to perform milling. Various machine tools are for milling is available, and the tools are encompassed in the milling machine or mill. Over time, the milling machine has undergone a series of upgrades and changes. Particularly, with the emergence of computer numerical control (CNC) systems, milling machines, or machining centers, are now embedded with an array of features such as automatic tool changers, tool magazines or carousels, CNC control, coolant systems, and enclosures, among others. New techniques for better milling methods and equipment have been critical areas of research in diverse industries in order to produce perfectly finished parts.

The patents listed in Exhibit 1 include a trend toward inventions in milling technologies for milling complex surfaces and work pieces. in this vein, a patent (EP 2846953), assigned to DP Technology Corp., pertains to an automated milling method for complex-shaped metal cavities. A patent (WO/2015/029814), assigned to Satake Corporation, is for a grinding type vertical grain milling machine. Apart from the milling machines, other inventions indicate research for development of tools for milling,

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Milling system for abandoning a wellbore	April 16, 2015/ WO/2015/054227	Weatherford/Lamb, Inc.	BANSAL, Ram K.	A mill for use in a wellbore includes a tubular housing having a bore therethrough and a plurality of eccentrically arranged pockets formed in a wall thereof and an arm disposed in each pocket. Each arm has a body portion and a blade portion extending from an outer surface of the body portion and is movable between an extended position and a retracted position. The mill further includes cutters disposed along each blade portion and a block disposed in each pocket and connected to the housing. Each block has a guide engaged with a mating guide of the respective body portion and an inner passage for providing fluid communication between the housing bore and the respective pocket. The mill further includes an actuator for extending the arms.
Method for machining materials by milling and subsequent brushing	March 18, 2015/ EP 2846963	Siemens AG	DAVID WALTER	The invention relates to a method for machining a material, in particular steel, wherein the material is milled at such a high cutting speed that residual tensile stresses close the surface that exceed a specified value can occur and the residual tensile stresses can be lowered below the specified value by subsequent brushing. The invention further relates to a device for performing said method.
Tool, toolholder and tool-toolholder unit for milling cutters and/or shredders	March 18, 2015/ EP 2848312	FAE Group SpA	SCANZONI DIEGO	The invention concerns a tool (10; 20), a toolholder (30; 40) and a tool-toolholder unit (70; 80; 90) obtained by coupling tool and toolholder and adapted to be fixed to a rotor of a shredder. The tool (10; 20) and the toolholder (30; 40) comprise coupling means that permit a quick and easy assembly or disassembly of the two elements and ensure, at the same time, a stable and safe fixing during the use of the tool itself.
Automatic method for milling complex channel-shaped cavities	March 18, 2015/ EP 2846953	DP Technology Corp	SONA GIULIANO	Methods and devices for milling a channel-shaped cavity by a five-axis computer numerical control (CNC) machine by selecting a workpiece to be machined (141,210), determining cutting tool flow along the channel-shaped cavity, determining cutting tool in-depth penetration, determining a trochoid path (815,240), and determining auxiliary movements (144,260).
Face milling tool	March 12, 2015/ WO/2015/032459	Audi AG	KOPTON, Peter	The invention relates to a milling tool for the face milling of a substantially planar workpiece surface (3), having a rotary movement (R) about a tool axis (W) at right angles to the workpiece surface (3) and having a feed movement (V) transversely to the tool axis (W) and along the workpiece surface (3), said milling tool (1) having at least one main cutting-lip element (23) having a face cutting lip (29) which extends as far as a radially outer cutting-lip corner (31) and by way of which material is removed to a nominal degree (n). According to the invention, the milling tool (1) has at least one clearance-groove cutting-lip element (21) which leads the main cutting-lip element (23) in the direction of rotation (R), said clearance-groove cutting-lip element (21) producing a clearance groove (41) in the workpiece surface (3), in which the radially outer cutting-lip corner (31) of the main cutting-lip element (23) is guided substantially without cutting load.
High performance multi-axis milling	March 11, 2015 EP 2845547	Celeritive Technologies Inc.	SHERBROOKE EVAN C	Technology for milling selected portions of a workpiece by a cutting tool of a numerical control machine is described. The described technology provides methods and apparatuses for milling areas of a part so that more aggressive machining parameters can be used in the toolpath, thereby resulting in reduced machining time and load. The described technology additionally determines directions of the tool axis vector at points along a toolpath in order to achieve a desired part shape while optionally maintaining high material removal rates.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Grinding type vertical grain milling machine	March 5, 2015/ WO/2015/029814	Satake Corporation	SETO, Yasuyoshi	A grinding type vertical grain milling machine (1) comprises a polishing roller (6) in which grinding stone disks (12) and dividing wall disks (14) are axially alternately arranged. The dividing wall disks (14) have a greater diameter than the grinding stone disks (12) and have protruding peripheral edges (13) protruding further outward than the peripheral surfaces of the grinding stone disks (12). A resistance body (31) is provided in a polishing chamber (18), and the resistance body (31) is provided with: inner side edges (29) located close to the peripheral surface of the polishing roller (6); and flow passage recesses (30) for rice grains, the flow passage recesses (30) corresponding to the protruding peripheral edges (13).
Milling and boring tool	February 19, 2015/US 20150050095	Mapal Fabrik für Präzisionswerkzeuge Dr. Kress KG	Krenzer Ulrich	A milling and boring tool with a tool shaft which comprises a center axis, at least one geometrically defined rough cutter and at least one geometrically defined finishing cutter, and the at least one rough cutter and the at least one finishing cutter respectively comprise a chip groove. The milling and boring tool is characterized in that the chip groove of the at least one finish machining cutter has an opposite twist than the chip groove of the at least one rough cutter.
Method for regularizing aperture shape for milling	February 19, 2015/ US 20150051434	Koninklijke Philips N.V.	Kumar Prashant	A therapy system (**20**) determines an aperture shape (**102, 152**) based on a diameter (**106, 156**) of a milling bit. The system (**20**) includes at least one processor (**68, 70**) programmed to receive an aperture shape (**102, 152**) of a treatment plan for a patient and a diameter (**106, 156**) of a milling bit. The aperture shape (**102, 152**) is regularized with respect to the diameter (**106, 156**) of the milling bit by at least one of over segmenting (**150**) a first portion of the aperture shape (**102, 152**) based on the diameter (**106, 156**) of the milling bit and under segmenting (**100**) a second portion of the aperture shape (**102, 152**) based on the diameter (**106, 156**) of the milling bit.
Milling machine	February 12, 2015/ US 20150043986	Gepro Systems, S.L.	Estancona Ercilla Jose Antonio	The invention relates to a milling machine comprising a frame (**2**) including a work surface (**2.1**) disposed in a vertical plane and a C-shaped moving bridge (**3**). In addition, the machine comprises: at least three heads (**7**), each head including a machining spindle (**15**); and five movement axes (X, Y, Z, A, B), such that the moving bridge (**3**) is moved by the frame (**2**) along a horizontal axis (X), and each head (**7**) is moved independently on the moving bridge (**3**) along a vertical axis (Y) in order to be moved towards or away from the work surface (**2.1**) along a depth axis (Z) perpendicular to both the horizontal axis (X) and the vertical axis (Y), as well as rotating independently about a first axis of rotation (A). Each spindle (**15**) rotates independently about a second axis of rotation (B).
Milling tools, method for making same and method of using same	February 12, 2015/ WO/2015/018842	Element Six Limited	O'Malley, Dermot Francis	A milling tool (10) having a longitudinal axis (A) about which the milling tool (10) will rotate in use, comprising a tool body (14) on which a plurality of cutter assemblies (16) are arranged azimuthally, each cutter assembly (16) comprising a plurality of super-hard cutter segments (12) attached to the tool body (14) in an axial arrangement, each cutter segment (12) having a cutting edge (13); in which the tool body (10) and the cutter segments (12) are configured such that the cutting edges(13) define a mean cut diameter of at least 6 (six) millimetres (mm) and a cut length of at least 1.5 times the mean cut diameter.

Exhibit 1 depicts patents related to milling process.

Picture Credit: WIPO Patentscope

Back to TOC

To find out more about Technical Insights and our Alerts, Newsletters, and Research Services, access http://ti.frost.com/

To comment on these articles, write to us at tiresearch@frost.com

---

You can call us at: **North America**: +1-843.795.8059, **London**: +44 207 343 8352, **Chennai**: +91-44-42005820, **Singapore**: +65.6890.0275

