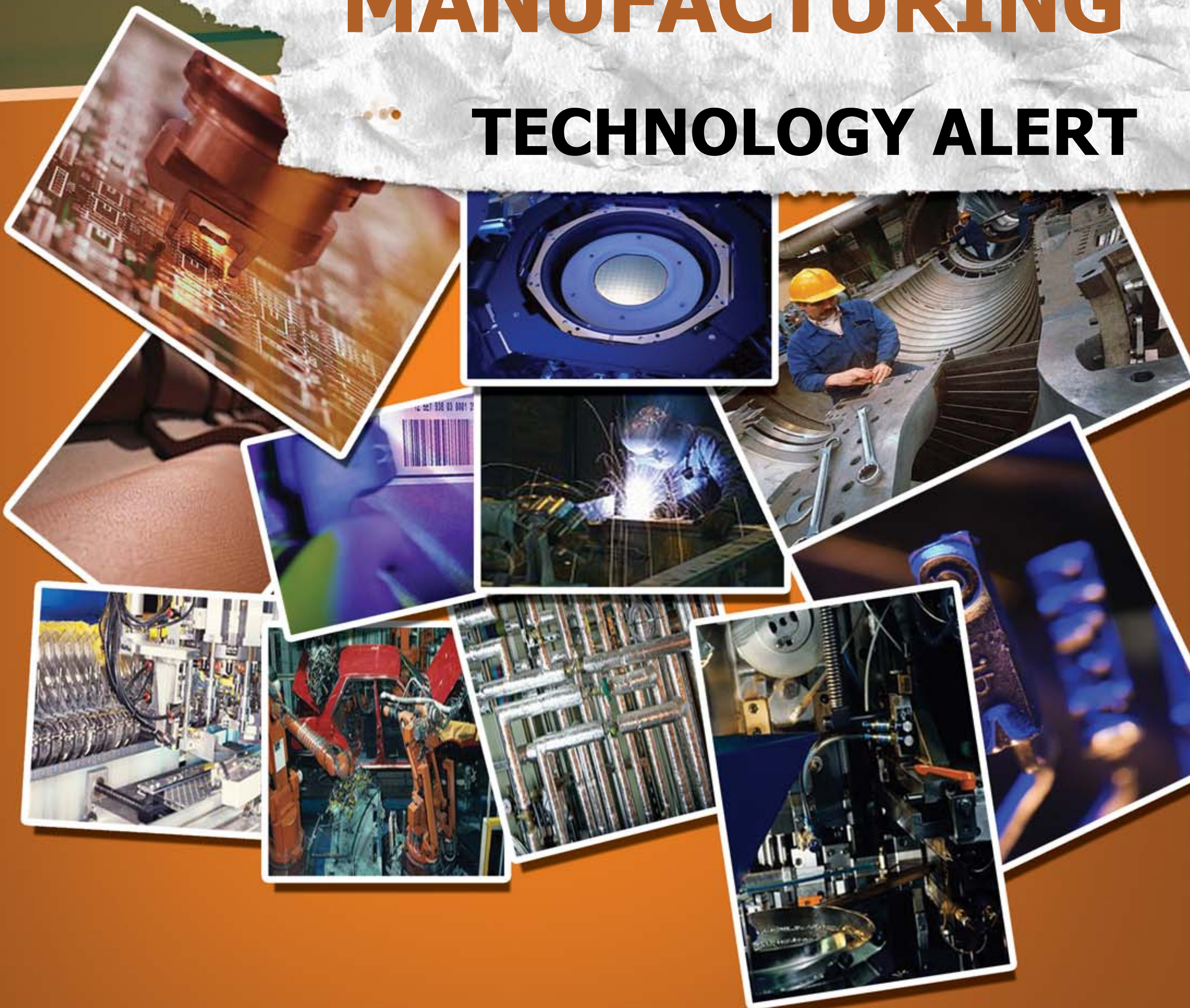
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



17th July 2015

1. NOVEL METHOD FOR MANUFACTURING NANOFIBERS

Nanofibers are a class of novel polymer materials with every constituent fiber having a diameter less than 100 nanometers. These nanofibers can be made from many natural materials such as proteins or from human-made substances to make plastic, rubber, fiber, and biodegradable materials. Nanofibers are being studied in various fields for potential applications. Researchers in the medical field are using nanofibers to develop advanced wound dressings. The thin width of nanofibers--they are thousand times thinner than human hair--has made medical researchers experiment with nanofibers for tissue regeneration, drug testing, stem cell therapy, and targeted drug delivery. Nanofibers are also being used for producing fuel cells, batteries, filters and light-emitting screens.

Recently, researchers at the University of Georgia have developed an unique and cost-effective method to manufacture nanofibers. This novel process is named as magnetospinning by researchers. This method is simpler than other methods of manufacturing nanofibers, is scalable, and is capable of producing nanofibers in large quantities. The nanofibers produced by this method can readily be integrated with an array of materials such as live cells and drugs among others.

The existing technology to produce nanofibers called ‘electrospinning’ requires special equipment and high voltage. This makes electrospinning not only costly, but also demands trained personnel to operate the equipment. In comparison, the magnetospinning process of University of Georgia researchers uses rather simple equipment.

The researchers used the desired polymer for the nanofiber in a melted form and mixed it with a magnetic material such as biocompatible iron oxide. The solution was then filled into a hypodermic needle and was placed next to a magnet located on top of a circular platter. The circular platter started to spin and the magnet passed by the needle’s tip. This attracted the magnetic material in the solution and a droplet of the solution stretched out of the needle and attached to the magnet creating a nanofiber string. As the spinning continued, nanofiber was continuously produced and wound around the circular platter.

The magnetospinning device created by the researchers is capable of spinning at a speed of 1000 revolutions per minute. At this speed, this device can produce very thin nanofibers of about 50 kilometers in length. The researchers have filed for a patent for this technology.

The researchers claim that the new process will eliminate the need for costly equipment to produce high-quality nanofibers. Apart from being cost-effective, the researchers reckon that the new method will encourage many researchers and industries to experiment with nanofibers.

Besides the above mentioned benefits, this novel method can be used to make nanofibers from proteins, nanotubes, fluorescent materials, therapeutic agents, and so on.

When scaled up for mass production, this new magnetospinning method will have various benefits over the present electrospining technology. Thus it will open a pathway for more research in nanofibers, which will eventually lead to more novel applications of nanofibers in various industries.

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2. NANOMETER-SCALE SEMICONDUCTOR CHIPS

In what can be credited as a breakthrough in semiconductor industry and the future of computing, researchers from the IBM Fellow Thomas J. Watson Research Center have produced 7 nm node test chips with working transistors on them. The 7 nm chip is an achievement in the semiconductor industry and the researchers worked in collaboration with research teams from Global foundries and Samsung to achieve this unique feat.

This novel achievement would make it possible for a chip, sized as small as a fingernail, to have as many as 20 billion working transistors on it. The new chip delivers higher performance, lower power and scaling benefits that are far more superior to the existing microchip technology. The researchers achieved all these characteristics on the chip by using many innovative processes and techniques that are new to the semiconductor industry. Some of the noteworthy innovations achieved during the production process are the use of silicon germanium (SiGe) channel transistors and extreme ultraviolet (EUV) lithography.

This innovation was achieved through a public-private partnership between an industrial alliance consisting of Global Foundries, Samsung, few equipment supplying companies, and the New York State. The project was also funded by IBM as part of its a five year investment plan ($3 billion) in semiconductor chip research and development. Research and development of the 7 nm chip took place in the nanotechnology research facility of SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering (SUNY Poly CNSE) in Albany, New York.

The researchers strongly believed that scaling the chips to 7 nm and beyond, is crucial for developing computers and electronic devices for the future. In order to achieve this objective, the researchers focused on intense basic research of semiconductor technology and have now pushed it beyond its present limits.

In terms of the innovative technologies used in producing the 7 nm chip, SiGe and EUV lithography take the spotlight. Silicon germanium semiconductor has many advantages over 'silicon-only' chip technology present in the current semiconductor technology. Generally, in transistor nodes that have width less than 10 nm, the silicon does not function effectively. This is because the conducting channel becomes very small for the transistor gate width of 7 nm, and silicon atoms cannot carry enough current at such small channel width. Germanium, another well-known semiconductor, increases electron mobility when added with silicon. The researchers took advantage of this fact and used SiGe to improve the conductivity at sub-10 nm channels.

Another interesting innovation is the use of EUV lithography. Argon fluoride (ArF) laser with a wavelength of 193 nm is the currently available state-of-the-art lithography technology used for etching features of 14 nm on chips. It takes a combination of several intricate operation steps and complex optics to apply ArF. But EUV has a wavelength of only 13.5 nm, enabling it to be used to etch sub-10nm features on the chip.

As of today, 22 nm and 14 nm semiconductor technologies are used in microprocessors to power servers, data centers, and mobile devices. The 10 nm semiconductor technology is becoming mature and is making its way into the market, while the 7 nm semiconductor technology is anticipated to be rolled out in the market in 2018.

The 7 nm semiconductor technology is reckoned to be a compelling factor in addressing the future demands in fields such as cloud computing, big data systems, cognitive computing, and many other emerging technologies. It is also believed that the next generation mainframe and power systems would get a power/performance improvement of at least a 50% because of the scaling improvements in the novel 7 nm semiconductor technology.

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3. NANOSTRUCTURED STRETCHABLE TRANSPARENT CONDUCTIVE STRUCTURE

Wearable sensors are increasingly attracting interest in the marketplace, as evidenced, for example, by the enthusiastic reaction to Fitbit's IPO on June 18, 2015, in which the fitness device manufacturing company raised nearly $740 million. Wearable sensors or systems are gaining traction because they dovetail with the burgeoning quantified self phenomenon. A wearable sensor allows for automatically recognizing the activity and behavioral status of the user and for understanding the environment around the user.

Key components of wearable sensor systems can include innovative stretchable and biocompatible materials, as well as, for example, real-time measurements of multiple chemical, physical, or electrophysical parameters; autonomous systems for monitoring such parameters as heart rate, hydration level, blood sugar, and so on; or ultra-low power or self-powered sensor systems.

Stretchable sensors are very suitable and beneficial for unobtrusive, comfortable sensing and monitoring of human body motion or other body parameters, such as heart rate, respiration, blood pressure, and so on. Moreover, stretchable sensors are able to conform to curvilinear and dynamic surfaces and can maintain suitable performance when bent or stretched. Such capabilities lend themselves to applications such as prosthetics, robotic systems with more sophisticated human-like sensory characteristics, and real-time monitoring of health and wellness.

It has been challenging to develop multi-functional wearable sensors that offer strong sensitivity and stretchability.

Researchers at the North Carolina State University have developed stretchable, transparent conductive materials that are configured in a nano-accordion design and have opportunities in wearable sensing as well as flexible electronics or stretchable displays.

The nanostructured stretchable conductive structure was crafted by first creating a three-dimensional (3D) polymer template, which has the shape identical rectangles and is coated with conductive aluminum-doped zinc oxide. An elastic polymer is applied to the zinc oxide. The template is created on a silicon substrate. Then, the structure is turned over and the template and silicon substrate are removed, resulting in symmetrical zinc oxide ridges on the elastic polymer substrate. The structure is transparent, since the zinc oxide and the polymer are clear materials. The ridges the zinc oxide enable the structure to expand and contract and, therefore, be stretchable.

The zinc oxide's thickness influences the optical, mechanical, and electrical properties of the structure. The researchers have controlled the thickness of the zinc oxide layer, from 30 to 70 nanometers.

Nanolithography and has been used to precisely engineer the 3D templates, since the structure's flexibility is impacted by the dimensions of each zinc oxide ridge. The structure's flexibility increases if the ridges are taller. The structures were fabricated using atomic layer deposition in combination with nanolithography.

The nanostructured material demonstrated a two-orders-of magnitude enhancement in stretchability, as well as repeatable electrical performance for cyclic stretching and bending, and broadband optical transmission up to 70%.

Although some conductivity is lost when the structure is stretched for the first time, its conductivity is not compromised by additional stretching. Moreover, the structure will not break with repeated stretching.

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4. PATENT ANALYSIS OF BROACHING PROCESS AND EQUIPMENT

Broaching is a machining process usually used while working with metals. It is considered to be the most precise machining process for metalworking. Broaching is widely used in the automobile industry among other industries such as manufacturing, heavy machinery, and so on.

A broaching machine typically consists of a tool called broach, which moves over the work piece and cuts a predetermined shape. The main advantage of broaching process is that it offers very less production price for the work pieces because the cycle time of broaching process is very less. This makes broaching an ideal method to be employed for high-volume production environments.

Almost any metallic alloys can be broached, but it is best suited for softer metals such as aluminum, copper alloys, and brass. Advancements in broaching have enabled this technique to be used in machining operations of non-metallic materials such as plastics, polymers, and wood.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Broaching cutter	June 4, 2015/ WO/2015/080122	AISIN AW CO., LTD.	YAMAYA Kenichi	A broaching cutter (1) has, sequentially from the upstream side of a cutting direction (S), a plurality of initial cutting edge tiers (2) for cutting a forming site of a tooth body (821) for a plurality of internal teeth (82), a plurality of intermediate cutting edge tiers (3) for cutting the forming site of the tooth body (821) deeper, and a plurality of final cutting edge tiers (4) for cutting a forming site for a clearance (822) located further back than the tooth body (821). A pair of distal end corners (311) of a plurality of cutting edges (31) in the intermediate cutting edge tiers (3) and a pair of distal end corners (411) of a plurality of cutting edges (41) in the final cutting edge tiers (4) are formed to have a larger chamfer shape than the chamfer shape of a pair of distal end corners (211) of a plurality of cutting edges (21) in the initial cutting edge tiers (2).
Turn broach machine	May 28, 2015/ US 20150147126	Hyundai Motor Company	Tae Jin Kim	A turn broach machine includes: a machining member machining a target to be cut; and an adaptor provided under the machining member, supporting the machining member, and adjusting a position of the machining member. At the time of adjusting a position of a segment of the machining member from a plate provided in an adapter, the segment does not manually move, but moves on an adjusting plate that is mechanically defined, such that work accuracy may be improved to increase marketability and a work time may be decreased to improve work convenience and productivity.
Device for keyway broaching	May 14, 2015 / US 20150132077	WTO Werkzeug-Einrichtungen GmbH	Tobias Fautz	A device for keyway broaching is provided with a housing, a drive shaft, a broaching carriage received and supported in the housing, a tool support connected to the broaching carriage, and a crank drive that couples the drive shaft and the broaching carriage with each other. The broaching carriage, when driven by the drive shaft, performs an oscillating movement comprising a cutting movement and a return stroke. A sleeve is arranged between the housing and the broaching carriage. A first seal is provided between the housing and the sleeve and/or between the sleeve and the broaching carriage. The tool support is connected to the broaching carriage with a rocking lever interposed between the tool support and the broaching carriage. The drive shaft has a control section that controls a relative movement between the rocking lever and the broaching carriage.
Tool for the turning/turn broaching of workpieces	January 29, 2015/ US 20150030397	Kennametal Inc.	Heinloth Markus	A tool for the turning/turn broaching of workpieces is provided, a carrier which can be attached directly or indirectly to a machine tool a plurality of segments which are fastened to the carrier. Each of the segments is provided with a plurality of tool bits. In addition, each of the segments is attached to the carrier by at least two fastening elements, which act obliquely to a plane (E) lying perpendicular to the rotational axis (R) of the tool.

Broaching electrode-tool	January 10, 2015/ RU 0002537410	N.A	Smolentsev Vladislav Pavlovich	FIELD: process engineering. SUBSTANCE: invention relates to machine building and can be used for broaching, mainly, of small-diameter holes in metal blanks. Electrode-tool comprises metal working part with working and process ends that allow the feed of working fluid to broaching zone. Besides, it includes dielectric guide to be displaced along metal working part. Said guide has lengthwise grooves, one allows feeding of said working fluid to working end in broaching zone via hydraulic manifold, branch pipe and opening in metal working part. One or several grooves are designed to allow a complete evacuation of working fluid on working end side from broaching zone as well as broaching products via skews made opposite said grooves in dielectric guide. Note here that ledges are made on dielectric guide inner surface on process end side to shutoff escape of said fluid from said grooves towards process end. EFFECT: higher precision and quality of surface layer irrespective of broaching depth. 4 dwg, 1 ex
Steel-backed bidirectional synchronous spline broaching device and using method thereof	October 29, 2014/ EP 2796235	UTIL Guangzhou Auto Parts Co. Ltd.	Oscar Finessi	The invention relates to a steel back two-way synchronous drawloom and a use method thereof. The drawloom comprises an upper die base, an upper die board, a lower die base and a lower die board, and further comprises a molded upper die and a working positioning lower die, wherein the molded upper die is mounted on the upper die board, and comprises a blade sliding board, a left blade, a right blade, a left inner slider, a right inner slider, a left outer slider and a right outer slider; the working positioning lower die is mounted on the lower die board, and comprises a concave die, a product floating block and a floating spring; the lower part of the lower die board is provided with a pushing rod; the lower die base is fixed and mounted with a left and right supporting blocks corresponding to the left and right outer sliders, and the left and the right supporting blocks are passed through and mounted on the lower die board lengthwise. With the adoption of a two-way synchronous broaching gear method, a gear of a product in the invention has the advantages of high density, high strength, as well as uniform and neat arrangement; furthermore, a brake pad of the product in the invention has the advantage of high shear strength. In addition, the drawloom has high production efficiency, stable whole production process, a firm gear root, and non easy falling, as well as is adaptable to be produced in mass.
Sealing type vertical broaching machine	October 13, 2014/ KR 101449492	-N.A-	Jeong, Jeong Hwan	Provided is a sealing type vertical broaching machine having a broach assembly which includes a ram unit installed at the front surface of a main body to be liftable; a jig unit installed at the upper surface of a mounting end of the ram unit to be horizontally movable and on which a workpiece is mounted; an upper-end clamping unit installed at the top of the front surface of the main body to be liftable and gripping the upper end of the broach tool; a lower-end clamping unit disposed at a bottom portion of the mounting end of the ram unit in the lower part of the front surface of the main body and gripping the lower end of the broach tool; and a sealing unit disposed at the front surface of the ram unit, and in which the lower end is in close contact with a circumferential portion of an axial coupling hole on the upper surface of the workpiece to make the airtight seal and a central portion is opened to enable the broach tool to pass. Therefore, cutting oil supplied when processing a broach is supplied only to the internal circumferential surface of the workpiece, thereby preventing unwanted leakage of the cutting oil. COPYRIGHT KIPO 2014
Broach tool rake face with a tailored surface topography	September 11, 2014/ US 20140255112	United Technologies Corporation	El-Wardany Tahany I.	A broach tool includes a broach tool rake face with a tailored surface topography.

Helical broach	August 21, 2014/ WO/2014/125872	Mitsubishi Heavy Industries Ltd.	Katsuki Yasuhito	The finishing part (4) of this helical broach (1) is formed by a first finishing shell (20) and a second finishing shell (30) which are divided in the axial direction, and is obtained by forming a first finishing blade (50), which comprises a prescribed tooth shape helix angle (α) and a first blade groove helix angle (β1), on the aforementioned first finishing shell (20) and forming a second finishing blade (60), which comprises the aforementioned prescribed tooth shape helix angle (α) and a second blade groove helix angle (β2) which differs from the aforementioned first blade groove helix angle (β1), on the aforementioned second finishing shell (30).
Broach and method for broaching slots for parts such as turbine rotor disks or turbomachine compressor disks	August 7, 2014/ WO/2014/118459	Turbomeca	Mandrile, Sébastien	The invention relates to the broaching of at least one slot (3) in a part such as a turbine rotor disk (4) or a turbomachine compressor disk, said slot (3) being machined by means of a broach (1) inclined at a broaching angle (a). Said broach (1) has an inter-tooth pitch (P) that is a sub-multiple of the length to be broached (L).

Exhibit 1 depicts patents related to broaching process and associated equipment.

Picture Credit: Frost & Sullivan

Exhibit 1 discusses about the latest patent activity in broaching process and associated equipment. Analysis of patents filed over the last 5 years reveals that research activities in broaching process are extensively carried out in USA, China, and Japan. An interesting patent filed by Hyundai Motor Company (US 20150147126) is for a broach machine that is designed to improve accuracy of the work piece and increase productivity.

Another interesting patent is filed by Kennametal Inc. (US 20150030397) discusses about a tool for the turning/turn broaching of workpieces on a broaching machine.

5. TECHVISION 2015

The TechVision program is the premier offering of Technical Insights, the global technology innovation-, disruption-, and convergence-focused practice of Frost & Sullivan. TechVision embodies a very selective collection of emerging and disruptive technologies that will shape our world in the near future. This body of work is a culmination of thousands of hours of focused effort put in by over 60 global technology analysts based in six continents.

A unique feature of the TechVision program is an annual selection of 50 technologies that are driving visionary innovation and stimulating global growth. The selected technologies are spread across nine Technology Clusters that represent the bulk of R&D and innovation activity today. Each Cluster represents a unique group of game-changing and disruptive technologies that attract huge investments, demonstrate cutting-edge developments, and drive the creation of new products and services through convergence.

Our technology analysts regularly collect deep-dive intelligence on several emerging and disruptive technologies and innovations from around the globe. Interviews are conducted every day with innovators, technology developers, funders, and others who are a part of various technology ecosystems. The respondents are spread across public and private sectors, universities, research institutions, and government R&D agencies. Each technology is rated and compared across several parameters, such as global R&D footprint, year of impact, global IP patenting activity, private and public funding, current and emerging applications, potential adoption rate, market potential, and so on. This organic and continuous research effort spread across several technologies, regions, organizations, applications, and industries is used to generate an annual list of Top 50 technologies that have the maximum potential to spawn innovative products, services, and business models.

Furthermore, we analyse several possible convergence scenarios where two or more of the Top 50 technologies can potentially come together to disrupt, collapse, and transform the status quo. Driven by IP interactivity emanating from each of the top technologies, a whole range of innovative business models, products, and services will be launched at unprecedented speed in the future. We have come up with over 25 such unique convergence scenarios.

The Top 50 technologies we have selected for TechVision 2015 have the power to drive unique convergence and catalyse wide-scale industry disruptions. Frost and Sullivan’s TechVision program empowers you with ideas and strategies to leverage the innovations and disruptive technologies that can drive the transformational growth of your organization.

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