TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

10th July 2015

1. MANUFACTURING TECHNIQUE TO REDUCE THE COST OF HYBRID VEHICLES

Currently, the cost of manufacturing vehicles is significantly high, primarily due to the expenses that are incurred while using platinum for catalyzing fuel cells. When placed on a solid surface, platinum material diffuses to form random particles that grow rapidly, which also limits their reactivity. Researchers have now discovered that the cost of catalyzed fuel cells can be significantly reduced when platinum materials are bonded with graphene.

Researchers from the University of Arkansas, Fayetteville, USA, in collaboration with the University of Missouri, USA, and Shanghai University, China, have discovered that that the platinum nanoparticles have the ability to limit their size and organize themselves into specific patterns when they are bonded to freestanding graphene. This unique behavior of platinum nanoparticles also creates an effective surface area that functions as a catalyst for chemical reactions. The researchers believe that this innovation could lead to the lowering of coss associated with production with platinum catalyzed fuel cells. The low-cost fuel cells could be employed for generating power in buildings, and also can be used as a replacement for internal combustion (IC) engines that are currently used in automotives.

Graphene has a flexible surface; and due to the local strain effects, the amount of platinum required for catalysis in fuel cells can be reduced by almost 80%, which reduces the manufacturing cost. The other innovation in this research is a functionally superior single crystal platinum nanoparticle from platinum by applying graphene on it. In recent times, the use of graphene in various applications has been on the rise; since graphene is one of the strongest, lightest, and most conductive materials having a one atom-thick sheet of carbon atoms. In addition to the above mentioned properties, the electrons moving through the

graphene material have less mass and resistance, thereby making it an ideal material for the future energy needs. In order to get a better understanding of the fundamental electronic and mechanical properties of graphene, the researchers working on this project have also used atomic scale imaging and manipulation to further advance the applications sectors for graphene. By combining various techniques, such as computational molecular dynamics and scanning tunneling microscopy, the theoretical model for manufacturing low-cost fuel cells was developed. With data obtained from various experiments, the researchers were able to achieve bonding of the graphene to platinum nanoparticles.

The advantage of this innovation is that, it can lead to the reduction in manufacturing cost of hybrid vehicles and other green energy applications in the future. With the entire world searching for ways to produce green energy, conserve non-renewable energy sources, and reduce vehicle emissions, this innovation has potential to be adopted on a large scale once it is commercialized.

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2. SIMULATION MODEL FOR TESTING OF VEHICLES

Simulation tools have been very important in the automotive industry to manufacture better products. Some of the key properties of the vehicle components, such as their responsiveness to accidents, reliability, and energy efficiency, are investigated using simulation tools.

A group of researchers from the Fraunhofer Institute for Industrial Mathematics (ITWM), Germany, has developed a novel interactive driving simulator using RODOS (robot-based driving and operation simulator). This interactive driving simulator is capable of providing and analyzing the realistic interaction between human and vehicles. Until now, algorithms have been largely used for representing the human in simulators. The major drawback in using algorithms is that they do not completely represent the human factor in simulations. In order to overcome the above mentioned drawback, researchers at ITWM have used a hybrid design for developing this novel simulator. By using a hybrid design, they have been able to replicate the exact human behavior in a simulation environment.

ITWM's simulation facility structure consists of a real vehicle interior where the test driver would be able to operate the steering wheel, accelerator, and brakes

like that of an actual car. The interior of the vehicle is integrated with a 6-axis robotic system that looks like a large gripper arm. This robotic arm has the capability to simulate acceleration, braking, and manoeuvring tight curves by leaning and rotating. For any test drivers to have a realistic atmosphere in a simulator, it is necessary to have a feeling that they are situated in a moving vehicle. If the movements of the simulators do not match the visual impressions, then it results in different driver reactions, which in turn affect the end result of the analysis. In order to prevent the miscalculations and to obtain fair analyses, the researchers at ITWN have developed and used motion curing algorithms, which generate control signals for the robot. With these control algorithms, it would be possible to match the motions of simulators to the visual input, which can be perceived in a natural way for the test drivers. This driving simulator has also taken into account the human effects on a vehicle, which is seen to be becoming more important these days.

According to the researchers, one of the key driving factors for this innovation is the growing number of driving assistance systems, which would make the human machine interface in automobiles increasingly important. The researchers at ITWN have developed the algorithms using their proprietary technology, which gives them the advantage of customizing it for specific industry players based on their demand and requirements. ITWN is currently working on two projects in collaboration with the Volvo Construction Equipment company.

The advantage of this novel simulator is that it provides a more realistic environment for testing automobiles and enables better analysis of the vehicles than conventional simulators. With new technologies that are being employed in automobiles increasing constantly, it has become increasingly necessary to have a simulator that is capable of providing a detailed analysis. This novel simulator has the potential to be adopted by automotive manufacturing companies in the future.

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3. 3D SCANNING TECHNIQUE TO CAPTURE AN OBJECT'S 3D SHAPE

Three-dimensional (3D) depth sensing, or the ability to acquire 3D images, has been gaining increased momentum in applications such as gesture recognition

and touchless sensing. Techniques used to acquire 3D image depth information include stereoscopic vision, structured light pattern, and time-of-flight (TOF).

In stereoscopic vision, two cameras are used to obtain a left and a right stereo image. A computer compares the two images to develop an image that pertains to the displacement of objects in the images.

Structured light uses a laser or LED (light-emitting diode) light to illuminate or create patterns to detect or scan 3D objects. As is the case with the stereoscopic system, triangulation is used to acquire the 3D coordinates of an object. In the structured light pattern approach, a single two-dimensional (2D) camera with an infrared or RGB (red, blue, green)-based sensor can be used to measure displacement of a stripe of visible or infrared light; and the coordinates, obtained through software analysis, can be used to create a digital 3D image of the shape. The structured light approach projects a pattern of light onto a 3D scene and infers or computes depth and the 3D structure from the deformation or distortion of that light pattern.

Time-of-flight technology transmits a light pulse from a light source (laser or LED) to an object. A receiver detects the reflected pulse and determines the distance of the measured object by calculating the travel time of the light pulse from the emitter (source) to the target and back to the receiver. In 3D depth sensors based on TOF, each pixel can measure the time the light has taken to travel from the illumination unit to the object and back to the image sensor.

Indicative of expanding opportunities for 3D scanning, researchers at Carnegie Mellon University (CMU; USA), under the leadership of Aswin Sankaranarayanan, assistant professor, department of electrical and computer engineering at CMU, are developing a 3D scanning technique that allows for capturing the interaction of each surface element on the object with light, in addition to capturing an object's 3D shape.

The bidirectional reflectance distribution function (BRDF), which defines how light is reflected at an opaque surface and how incident light on a material is distributed in different directions, is utilized in computer graphics for photorealistic rendering and in computer vision for applications such as object recognition.

The researchers' proposed technique estimates the BRDF at each surface element of the object in isolation. This capability renders the approach suitable for very visually complex objects. The solution is facilitated by knowledge about how many commonly occurring materials interact with light. Then, one can attempt to explain an object's visual properties of an unknown composition in terms of

behavior shown by the commonly occurring materials. This capability can significantly reduce the problem's complexity and facilitate modeling and analyzing the object's shape and resistance.

This technique is envisioned to be beneficial for applications such as augmented reality, 3D printing of materials of visual complexity, and digital museum applications.

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4. PATENT ANALYSIS OF WATER JET CUTTING PROCESS AND EQUIPMENT

Water jet cutting is a popular cutting method used in several manufacturing industries, as the technique can be used to cut materials such as textiles, metals, rubber, foam, plastics, leather, composites, stone, tile, glass, ceramics, food, paper and so on. Water jet cutting equipment uses water jets to cut just about any material placed in front of it in the form a sheet, except diamonds, tempered glass, or certain ceramics.

Water jets used for industrial cutting application are usually pressurized between 1300 to 6200 bars of pressure. Then, the pressurized water is forced through a tiny hole in the jewel of the cutting machine. The hole is typically 0.18 mm to 0.4 mm in diameter. The narrow dimensions of the hole create a very thin beam of water that travels almost at the speed of sound–-about 950 km/h (kilometers per hour). Pure water jets are used for cutting some soft materials such as food, rubber, and foam. For cutting harder things such as metals and stones, an abrasive is added into the water jet. The abrasive is added into the water stream and mixed with the water jet as it leaves the jewel.

The most popular materials that are cut using water jets are metals. Aluminum in particular is often cut using water jets because it is comparatively soft and cut quickly than other metals. Water jets cut intricate shapes at a high precision, quickly and economically.

Exhibit 1 lists some of the patents in water jet cutting process and equipment granted during June 2014 to June 2015. It can be noted that more patents are filed from China, which indicates that continuous research activities are carried out in water jet cutting in this region.

Patents filed by Harbin Engineering University (CN 103894936) and Water Jet Sweden AB (EP 2853349) pertain to an abrasive water jet cutting head and to an abrasive water jet cutting nozzle, respectively.

Title	Publication Date/ Publication Number	Assignee	Inventor	Abstract
Abrasive water jet cutting nozzle	April 1, 2015 / EP 2853349	WATER JET SWEDEN AB	RYD TONY	The present invention relates to an abrasive water jet cutting nozzle (44) comprising a first body (66), a second body (82), a collet (60), a jewel element (75). The first body (66) comprises a first downwardly diverging frusto conical shaped recess (78) and the collet (60) comprises a first downwardly diverging frusto conical shaped surface (80) adapted to fit in the first downwardly diverging frusto conical shaped recess (78). The second body (82) comprises a second downwardly diverging frusto conical shaped recess (90). The first body (66) further comprises a second downwardly diverging frusto conical shaped surface (94) adapted to fit into the second downwardly diverging frusto conical shaped recess (90).
Water jet cutting focusing tube, water jet cutting mixing chamber and water jet cutting focusing tube with integrated mixing chamber	April 1, 2015/ EP 2853348	WATER JET SWEDEN AB	RYD TONY	The present invention relates to a water jet cutting focusing tube (44) comprising an elongated tubular body (46), having a generally circular cross section, with an upstream end (48) and a downstream end (50). The upstream end (48) comprises an inlet (52) and the downstream end (50) comprises an outlet (56). The elongated tubular body (46) comprises a flat outer surface (5 8) extending along a substantial portion of the length (L1) of the water jet cutting focusing tube (44). The present invention also relates to a water jet cutting mixing chamber (60) and a water jet cutting focusing tube with integrated mixing chamber (82).
WATER-JET OPERATING HEAD FOR CUTTING MATERIALS WITH A HYDRO-ABRASIVE HIGH PRESSURE JET	November 12, 2014 / US 20140329445	Biesse S.p.A.	Traini Matteo	A water-jet operating head for cutting materials by a high pressure hydro-abrasive jet includes a main portion which is to be carried by an operating machine movably along one or more axes and a focusing nozzle for ejecting the high pressure hydro-abrasive jet, carried by a support removably connected to the main portion of the head. This support also carries a primary nozzle with an orifice having a predetermined diameter arranged upstream of the focusing nozzle. The high pressure water jet is added with an abrasive agent which is fed through at least one connecting element at a mixing chamber interposed between the primary nozzle and the focusing nozzle. The connecting element is associated to the main portion of the head and the nozzle-carrying support is adapted to be slidably received within a cylindrical cavity of a main support forming part of the main portion of the head.
HIGH-PRESSURE WATER JET ASSISTED CUTTING MECHANISM FOR HEADING MACHINE	September 18, 2014 / WO/2 014/139339	CHINA UNIVERSITY OF MINING AND TECHNOLOGY	LIU, Songyong	A high-pressure water jet assisted cutting mechanism for a heading machine comprises a drive apparatus (1), a reducer (2), a cutting arm (3), a cutting head (4), a built-in inner spray and high-pressure water delivery system (5) all sequentially connected. The drive apparatus (1) comprises a motor, a connection frame (1-3) and an output shaft I (1-4). The reducer (2) comprises: a reducer casing, a coupling sleeve (2-1), a sun shaft I (2-2), a first stage planet carrier, a sun shaft II (2-3), a second stage planet carrier, and an output shaft II (2-4). The cutting arm (3) comprises a main spindle (3-1), a housing (3-2), and a connection flange (3-3). The cutting head (4)

				comprises hydraulic cutting tooth assemblies (4-1), a nozzle (4-2), and a cutting head welding assembly (4-3). The inner spray and high-pressure water delivery system (5) comprises a spray water input duct (5-1), a high-pressure water input duct (5-2), a spray water path (5-3), a high-pressure water pipe (5-4), a spray water output duct (5-5), a high-pressure water output duct (5-6), a spray chamber (5-7), and a high-pressure water chamber (5-8). Based on keeping an inner spray system, high-pressure water is introduced, the layout is proper, the structure is compact, and the objectives of improving efficiency, reducing work dust, and extending service life of a cutting tool are achieved.
Cutting system with multi-cutter-bit high-pressure water jet cutters	August 6, 2014 / CN 103963149	JINCHANG WANLONG INDUSTRIAL CO., LTD.	NAN HONGGANG	The invention provides a cutting system with multi-cutter-bit high-pressure water jet cutters. The cutting system is a transverse length-fixed quick cutting system consisting of a plurality of water jet cutter cutting heads and a movable water jet cutter cutting head; the water jet cutter cutting heads have a longitudinal cutting function; the cutting system is a portal support which is perpendicular to the material conveying direction of a rock mineral wood boards; the portal support is a water jet cutter rack which is adjusted transversely; the water jet cutter rack is provided with a fixed type cutting water jet cutter; a row of feeding pinch rollers which can be adjusted vertically are fixed on the portal support; a door type driving device is arranged beside the portal support; a trolley which walks along a cross beam is arranged on the cross beam of the door type driving device; and a movable type cutting water jet cutter is arranged on the trolley. A wastewater and waste material recycling system is arranged below the cutting system with the high-pressure water jet cutters; the production efficiency of the cutting system with the high-pressure water jet cutters is high; and the quality of products is also high.
Three-phase cavitation abrasive water jet cutting device	July 16, 2014 /CN 103921216	CHINA OCEAN ENGINEERING CORPORATION	AN XIANGRUI	The invention relates to a three-phase cavitation abrasive water jet cutting device. The three-phase cavitation abrasive water jet cutting device comprises a water tank, a filter, a cavitation plunger pump, a safety valve, a pressure adjusting valve, a tee joint, a abrasive tank, a rotary shower nozzle, a mixer and a cutting nozzle, wherein one end of the filter is communicated with the water tank by a pipeline and the other end of the filter is communicated with one end of the cavitation plunger pump by a pipeline; the safety valve and the pressure adjusting valve are communicated with the other end of the cavitation plunger pump by pipelines respectively; one opening of the tee joint is communicated with the pressure adjusting valve, one opening of the tee joint is communicated with the abrasive tank and the rest opening of the tee joint is communicated with the mixer; the rotary shower nozzle is mounted in the grinding material tank; the bottom of the grinding material tank is communicated with the mixer; one end of the mixer is communicated with the water tank and the other end of the mixer is communicated with the cutting nozzle. The three-phase cavitation abrasive water jet cutting device has a wide washing range, is suitable for cutting environments on and under the sea, and is particularly used for cold cutting in flammable and combustible dangerous environments.

Abrasive water jet cutting head	July 2, 2014 / CN 103894936	HARBIN ENGINEERING UNIVERSITY	YAO SHAOMING	The invention aims to provide an abrasive water jet cutting head. The abrasive water jet cutting head comprises a base, a water valve, a connector, a restriction choke and an abrasive device, wherein the abrasive device comprises an abrasive pipe, an abrasive cavity and a converging pipe; the abrasive pipe is installed on the abrasive cavity and is communicated with the abrasive cavity; the converging pipe is positioned at the outlet end of the abrasive cavity and is communicated with the abrasive cavity; the water valve is installed on the base; a high-pressure water inlet of the connector is installed below the water valve; a high-pressure water outlet of the connector is connected with the inlet end of the abrasive cavity by the restriction choke; after entering the connector by the water valve, high-pressure water is jetted into the abrasive cavity by the restriction choke, and vacuum is formed in the abrasive cavity; abrasive is sucked into the abrasive cavity by the abrasive pipe, and is jetted out by the converging pipe after being accelerated in the abrasive cavity. The abrasive water jet cutting head provided by the invention can be close to a cut root part furthest, so that the residue height after cutting is minimum.
WORKPIECE FIXTURE OF FLUID JET CUTTING SYSTEM	June 26, 2014 / WO/2014/099401	FLOW INTERNATIONAL CORPORATION	HASHISH, Mohamed, A.	A workpiece fixture assembly is provided to support a workpiece to be processed by a fluid jet cutting system. The workpiece fixture assembly includes a main support structure having at least one exterior portion and at least one interior portion separated by a tool path corridor and includes at least one supplemental support structure rigidly coupling the at least one exterior portion of the main support structure to the at least one interior portion of the main support structure and spanning beneath the tool path corridor at one or more crossing locations. A device is also provided beneath the main support structure to aid in preventing contents of a fluid jet from rebounding toward the main support structure after passing through the tool path corridor thereof during a workpiece processing operation.
Water jet flow cutting machine	June 11, 2014 /CN 103846809	ZJMECH TECHNOLOGY CO., LTD.	SONG MINRU	The invention provides a water jet flow cutting machine. The water jet flow cutting machine comprises a Y-axis part, a Z-axis fixed seat part, a Z-axis part, a cutting platform, a zinc-plated strip, a button box, a sand box, a grinding material feeding device and a cutting head, wherein a feeding system is composed of the sand box and the grinding material feeding device; the sand box is composed of upper and lower hoppers which are connected together by a flange provided with a sealing ring; the upper hopper is used as a material storage tank and can be used for holding a lot of grinding materials; the storage amount of the grinding materials can be measured by an inductor; the lower hopper is internally provided with a mini-type air cylinder; an air cylinder cap moves up and down to close or open the upper and lower hoppers for communication. The water jet flow cutting machine is provided with a sand conveying system with an amount control device so as to avoid wasting sand stones in a production process and save the production cost.
Guided water-jet mountain-cutting land reclaiming and mud solidifying treatment construction method	June 11, 2014 /CN 103850239	LANZHOU UNIVERSITY OF TECHNOLOGY	DONG JIANHUA	The invention provides a guided water-jet mountain-cutting land reclaiming and mud solidifying treatment construction method. The construction method comprises the steps of constructing in middle and lower narrow sections of a valley, digging out draining wells in a plurality of stages of earth dams, excavating a guide groove in the top of the mountain, feeding water and pushing earth into the guide groove, blending the mud with earth and a solidifying agent,

				pumping water out of the draining wells, filling earth on the upper part of the mud, spreading and rolling the filled earth. The guided water-jet mountain-cutting land reclaiming and mud solidifying treatment construction method belongs to the technical field of mountain-cutting land reclamation and is applicable to the space engineering of the hilly city development land; the construction method is novel in idea, achieves the purposes of reduction of construction time, reduction of construction cost and low environmental pollution, and promotes the development of the water-jet mountain-cutting land reclaiming technology in the municipal engineering.

Exhibit 1 depicts patents related to water jet cutting process and equipment.

Picture Credit: Frost & Sullivan

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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