TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

07th August 2015

1. NOVEL METHOD FOR REALIZING FAST PLASMONIC CHIPS

There are ever-increasing needs for achieving faster computing.

A team of researchers from the Laboratory of Nanooptics and Plasmonics at the MIPT Center of Nanoscale Optoelectronics, Moscow, Russia has developed a novel method for on-chip optical communication. The invention is believed to increase the performance of future computers by reducing the optical and optoelectronic components on computer chips.

In today's electronics, electrons as data carriers are failing to meet the high-speed computing requirements. The semiconductor channels and copper wires on computer chips are not able to transfer data at speeds expected for optimal performance of the current microprocessors (chips). This shortcoming demands for implementation of rather advanced technologies to transfer data at very high speeds on chips to maintain Moore's law.

One such approach is to increase data speeds on chips using optical pulses in the place of electrical signals. There are various research studies across the world in the semiconductor industry and academia to implement optical communication technologies on chips for development of high-speed computers for the future. Optical signals travel at the speed of light and hence transfer data at very high speeds. Also, optical signals can increase the performance of chips significantly. However, using optical signals for on-chip communication encounters a major shortcoming called 'diffraction limit.' Simply put, optical elements such as waveguides, attenuators and many more should have dimensions larger than the light wavelength in order to transmit optical (light) signals. The wavelength of light used for optical communication is chosen from the near-infrared radiation spectrum, which has a wavelength in the order of micrometers. This means that the optoelectronic components on the chips should have dimensions in micrometers for feasible optical communication. But today's electronics already

has reached a stage where the components on the chip are made in dimensions of nanometers. This brings the biggest challenge of scaling optical electronics to make it a competitive technology for high-speed nanoscale electronics of the future.

The 'diffraction limit' can be possibly overcome by using surface plasmon polaritons. Polaritons are quasi-particles (photons or electrons), which are collective excitations that emerge due to interaction between photons and electron oscillations on the boundary between a metal and an insulator. Plasmon polaritons also bring a possibility for switching to two-dimensional optics from the existent three-dimensional optics for optimal performance of optoelectronic components on chips. In perspective, plasmon polaritons can be considered as a 'compressed' photon. Since photons occupy volume (on the order of the light's wavelength) in space, they can be compressed and transformed into a surface plasmon polariton. The particles greatly increase the integration density of optical circuits and at the same time reduce the size of optical components on chips. Although, the use of polaritons for optical electronics seems like an extraordinary solution for scaling optical devices to the nanoscale, the flipside of this approach is that, for the surface plasmon polariton to exist, a metal, or more specifically, an electron gas in the metal, is needed. This leads to a very high energy loss similar to energy loss that occurs due to resistance in electrical conduction.

The research team, led by Dmitry Fedyanin has developed a method to counter the problem of energy loss during polariton conduction, paving way for making efficient and high-speed electronic chips for the future. The researchers explain that the energy of surface plasmon polaritons drops by a billion times for a movement of one millimeter, rendering no practical use for surface plasmon. In their approach, the researchers have developed a method for compensating the energy loss due to polariton movement using electrical pumping. The novel method, called electric pumping of plasmonic waveguides, is based on a metal-insulator-semiconductor (MIS) structure. The researchers have carried out successful simulations of this method.

Upon analyzing the results, the researchers have concluded that passing of relatively weak pump currents through the nanoscale plasmonic waveguides could easily compensate for surface plasmon propagation losses. Also, the researchers observed that the integration density of the plasmonic waveguides was higher than that of existing photonic waveguides. The researchers are now looking forward to verifying their results through practical experimentation of their observation through simulation. However, they reckon that, with their new breakthrough method, one of the major hurdles for optoelectronics for fast data transfer on chips has been eliminated.

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2. GRIPPING ROBOT WITH IMPROVED DEXTERITY

Industrial robots found on the factory floors across the world often are equipped with large claws that enable them to do simple manoeuvres like picking up an object, placing it in some place on the assembly line, and so on. However, more complex functions such as grabbing an object at a specified spot on it, or adjusting the grasp on the object are yet to be featured on many industrial robots.

In an attempt to embed robots with complex functions, a group of engineers from the Massachusetts Institute of Technology (MIT) has developed a mechanism that will improve the dexterity of robots. Robotic grippers will be able to grasp objects with more dexterity using the surroundings as a helping mechanism. The model robot, developed by the engineers, will be able to adjust the grasp on the objects by pushing the object against various fixtures in the robot's surroundings. The model robot also predicts the necessary force required to push the object for optimal grasping.

Imagine a robotic gripper aimed to grab a pencil by its midpoint, but the gripper ends up grabbing the pencil by its eraser end. In a conventional robotic gripper, the pencil is adjusted manually or the robot drops the pencil and aims again to pick up the pencil by its midpoint. The new robot developed at MIT will slightly loosen the grip and move to a nearby wall or any other fixture and push the pencil just enough to align the pencil's midpoint with the gripper.

The engineers have termed this approach 'extrinsic dexterity' (intrinsic dexterity is a feature used by human hands to achieve the same task). In perspective, a human would simply achieve the grip by using a single hand by spider-crawling the fingers toward the midpoint of the pencil. Although, the engineers believe that imitating the functions of the human hand is crucial for developing advanced robots for the future, they also believe that such robots would cost high and may be unsuitable for simpler applications.

The engineers designed this model robot to evaluate the effective interaction between a grasped object, gripper, and various types of fixtures in the surroundings, such as corners, walls, edges, and surfaces. Further, to evaluate the object's movement when the gripper pushes it against a particular fixture, the

model robot is equipped with design elements that take into account various environmental factors, such as frictional forces between the gripper and the object, frictional forces between the object and the environment, as well as the object's mass, inertia, and shape to produce an optimum dexterity.

Currently, the MIT engineers are working on developing ways to generate certain trajectories in the robot's motion. Further, they are planning to develop fixtures in the environment, where the robot's motions will be swifter and more reliable.

The new robot is a promising development in the industrial robot sector. The novel approach to increase the dexterity of robots will enable the existing robots in the fields such as manufacturing, medicine, disaster response, and other gripper-based applications to perform complex maneuvers by interacting with the environment in a cost-effective way.

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3. COST-EFFECTIVE MANUFACTURING APPROACH FOR LITHIUM-ION BATTERIES

The battery manufacturing industry has been performing research on different methods to produce more effective batteries at a lower cost. The current manufacturing process of lithium (Li)-ion batteries for over a decade consists of many complicated processes and components.

Recently, a group of scientists from MIT in collaboration with an MIT spinoff company called 24M, has developed an advanced manufacturing process to produce more efficient Li-ion batteries, which takes less time than the conventional process. The new manufacturing process and the battery are based on a concept developed by one of the researchers in the Materials science and Engineering department of MIT. The concept is known as a flow battery. The electrodes of this concept battery are suspensions of tiny particles carried in a liquid.

While the traditional Li-ion battery has a solid electrode design, the new battery developed by the researchers is a hybrid of a solid and flow battery. In the hybrid design, the electrode material is a colloidal suspension of particles in a semisolid state. The researchers claim that this design simplifies the manufacturing process, making the battery more flexible and damage resistant.

The flow battery system works better with low-energy density, which means, that for a given weight of electrodes, only a limited amount of energy can be stored. However, for high-energy batteries such as Li-ion batteries, the flow approach only increases the cost of the battery. To overcome this shortcoming, the researchers have recreated the flow battery design to develop a new process in which the electrode material is maintained in the liquid state rather than drying it.

In the conventional manufacturing process of solid batteries, a coating of electrode material is applied on the electrode in liquid form and dried before the electrode moves to the next manufacturing step. In comparison, in the new approach, the researchers have retained the electrode material in a liquid form. Since drying is not required, the manufacturing time is reduced by nearly 50%. Further, this new design enables the Li-ion battery to have less but thicker electrodes. This will reduce the number of vivid layers and also eliminate unnecessary materials in the battery.

The biggest advantage of using electrode material in liquid form is that the path length for the charged particles to move between the electrodes is greatly reduced. The path of movement of charged particles is also known as 'tortuous' path. Achieving less tortuous path enabled the researchers to uses thicker electrodes, which in turn makes the manufacturing process simpler and cost-effective.

The new manufacturing process has enabled the conventional rigid Li-ion batteries to be foldable and bendable. The new Li-ion battery is capable of handling high stress without cracking and it can be bent or folded with ease. This new property provides more safety and durability.

So far 24M has developed about 10,000 such new Li-ion batteries as prototypes. Most of the batteries are being tested at different companies, including oil and heavy equipment manufacturers. The new manufacturing process by 24M for making Li-ion batteries has received as many as 8 patents, and close to 75 patents are still under review. The company has received funding through many venture capital firms. It has also received a grant from the US Department of Energy (DOE). Sources from 24M believe that this technology is well suited for electric vehicles and other electrical machines, and would enable producing Li-ion batteries that would cost just $100 per kilowatt-hour of capacity. While this technology will have to address a few issues before its commercialization, it could be the breakthrough or pivotal technology for powering next generation electronic devices.

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4. PATENT ANALYSIS OF CARBON DIOXIDE ARC WELDING PROCESS

Shielded inert gas welding (MIG) is a type of welding process that makes use of inert gases (such as argon and helium) to shield or protect the molten metal during the welding process against reacting with other gases in the environment.

Carbon dioxide is a popular Inert gas used as a shield gas in the welding process. In most applications, carbon dioxide is used as a shielding gas in the flux core arc welding process (FCAW).

In carbon dioxide arc welding, carbon dioxide increases the heat input applied on the metal surfaces to be joined. However, carbon dioxide creates excessive weld spatter when used in the pure form. Hence, in most of the FCAW welding processes, a mixture of argon and carbon dioxide is used in the ratio of 3:1.

Carbon dioxide FCAW welding is widely used in industries for medium and heavy structural fabrication. The weld produced in this application usually is of superior quality and has a very high deposition rate.

Exhibit 1 depicts various patents for carbon dioxide arc welding process in the last three years. The patents filed over this time reveal that the research on the carbon dioxide arc welding process and equipment is predominantly occurring in China.

One of the interesting patents filed for the carbon dioxide arc welding process (KR 1020140094822), assigned to Joung Hung Kim, pertains to a torch device capable of adjusting the current and voltage of carbon dioxide arc welding machine. Another interesting patent (KR 1020140126530), assigned to Jae Sung Ha, pertains to a carbon dioxide arc welding machine equipped with a sensor that will detect the leaked carbon dioxide in the welding environment.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract

Auxiliary device of carbon dioxide arc welding equipment	March 4, 2015/CN 104384688	Anhui Honglu Steel (Group) Co. Ltd.	Ye Zhenglin	The invention provides an auxiliary device of carbon dioxide arc welding equipment. The auxiliary device is a multi-joint movable support arm which is used for hanging a welding machine cable and driving the cable to carry out hanging movement, and the front end of the movable support arm is provided with a handpiece fixing protection frame. The movable support arm can be used for hanging the welding machine cable and driving the cable to carry out the hanging movement so as to avoid phenomena in the prior art that the cable is abraded, broken or snapped. When a welding position is changed, the movable support arm moves to drive the cable to move so as to regulate the handpiece of the welding machine to a required position, the welding equipment is effectively protected, fault happening probability is lowered, welding efficiency is improved, and the labor intensity of welding personnel is relieved.
Carbon dioxide arc welding machine	October 31, 2014/KR 1020140126530	Ha, Jae Sung	Ha, Jae Sung	The present invention relates to a carbon dioxide arc welding machine for alarming by sensing the accumulated leakage of carbon dioxide leaked inside a welding workplace comprising: a sensor (210) for sensing the accumulated leakage of carbon dioxide generated in welding; and an alarming part (251) for generating the alarm when the accumulated leakage of carbon dioxide sensed by the sensor exceeds the predetermined reference value based on a signal outputted from the sensor.
Torch device capable of adjusting current and voltage of carbon dioxide arc welding machine	July 31, 2014/KR 1020140094822	Kim, Joung Hung	Kim, Joung Hung	The present invention relates to a torch device capable of adjusting current and voltage of a carbon dioxide arc welding machine which is well used in a welding industrial site. The welding machine necessary for welding work which is capable of manufacturing a welding structure is a welding source, a welding cable, a wire feeding device, a welding torch, etc. A current and voltage adjusting volume is directly installed in a torch of a carbon dioxide welding machine, so an electric wire is connected along a control cable, and a torch cable protects thereof. A volume is installed to adjust the output voltage of a welding machine and the wire speed in welding or before and after welding. Therefore, a welding defect generated in welding can be prevented, and the high quality welding product can be manufactured thereby. A welding torch clip (9) can be mounted on a current volume (6) and a voltage volume (7), and the current volume (6) for determining the speed of a welding wire by receiving the current outputted through a control terminal is mounted on a welding torch. The voltage volume (7) adjusts the voltage, so the output voltage of the welding machine can be adjusted. A control cable (13) is built in and connected to the inside of the torch cable (10). A feeding motor is operated and carbon dioxide is supplied by the operation of a micro switch (8). The current is supplied to the wire of the welding torch, and an arc is generated according to the welding source set thereby. Therefore, continuous welding, which a user desires, can be performed. COPYRIGHT KIPO 2014
Titaniferous metal flux-cored wire for carbon dioxide arc welding	March 26, 2014/CN 103659045	Kunshan Gintune Welding Co. Ltd.	Cai Hongxiang	The invention discloses a titaniferous metal flux-cored wire for carbon dioxide arc welding. The flux-cored wire is composed of a steel-tape sheath and metal flux core powder, wherein the weight of the metal flux core powder accounts for 10-30% of the total weight of the wire. Based on the total weight percentage of the steel-tape sheath, the steel-tape sheath comprises, by weight, 0.001-0.030% of C, 0.001-0.030% of Si, 0.01-0.30% of Mn, 0.001-0.035% of Al, 0.001-0.020% of P, 0.001-0.020% of S and the balance of Fe. Based on the total weight percentage of the metal flux core powder, the metal flux core powder comprises, by weight, 0.1-5.0% of fluoride, 0.01-0.20% of C, 10-18% of Mn, 3-8% of Si, 0.01-1.5% of Zr, 0.1-5.0% of Ti and the balance of Fe. According to the flux-cored wire, gas cost is reduced, the defect that splashing occurs frequently during welding is

				overcome, continuous welding is achieved, slag removing is not needed, labor efficiency is greatly improved, and deposited metal obtained has excellent mechanical performance especially impact toughness.
Anti-blocking processing system for welding gun nozzles for carbon dioxide arc welding	February 5, 2014/CN 103551715	Tianjin Boxin Automobile PArts Co. Ltd.	Li Jianguo	An anti-blocking processing system for welding gun nozzles for carbon dioxide arc welding is used for solving the blocking problem of the welding gun nozzles for the carbon dioxide arc welding. The anti-blocking processing system for the welding gun nozzles for the carbon dioxide arc welding comprises a liquid storage tank, a splash-proof liquid spraying device, welding gun placing supports and a PLC (Programmable Logic Controller) control mechanism; the liquid storage tank is filled with splash-proof liquid; a compressed air inlet pipe is arranged at the top of the liquid storage tank; liquid outlet pipes are arranged at the bottom of the liquid storage tank; the splash-proof liquid spraying device comprises a group of splash-proof liquid spraying units which are in series connection with the liquid outlet pipes of the liquid storage tank; the number of the splash-proof liquid spraying units is matched with that of welding guns in welding production lines; movements of the splash-proof liquid spraying units are controlled by the PLC control mechanism; the welding gun placing support is arranged at the tail end of every splash-proof liquid spraying unit. The anti-blocking processing system for the welding gun nozzles for the carbon dioxide arc welding has the advantages of reducing labor intensity of operators, improving welding production efficiency, effectively avoiding the welding gun nozzles from blocking caused by splashing of welding slags and poor electric conduction between a contact nozzle and a welding wire and caused by a processing method of dipping anti-blocking paste and satisfying a workpiece requirement for welding quality.
Method of weld joint alloying at arc welding in atmosphere of carbon dioxide	September 20, 2013/RU 0002492979	-N.A-	Edward G. Babenko	FIELD: process engineering. SUBSTANCE: invention may be used in reconditioning by welding or surfacing on machine parts made of high-alloy steels in atmosphere of carbon dioxide. Alloying film-like elements are pre-applied on part surface at would be weld joint by spark surface processing using high-alloyed electrode wire. Low-alloyed consumable wire is fed in welding area to fire electric arc between wire and part being reconditioned at simultaneous feed of carbon dioxide in said area. Note here that molten pool is made from high-alloyed elements. EFFECT: weld joint metal strength increased to magnitudes required for reconditioning by transfer of alloying elements in weld joint. 1 tbl, 7 ex
Argon-rich carbon dioxide arc welding method	December 12, 2012 /CN 102814576	China National Chemical Engineering No.14 Construction Co., Ltd.	Hu Qiuying	The invention discloses an argon-rich carbon dioxide arc welding method. The method comprises the following steps of: 1) machining a welded joint groove of a welded member; 2) determining the proportion of an shielding gas; 3) welding according to a welding process standard, and the welding process requirement includes: a) the shielding gas is a mixed gas of argon and carbon dioxide, wherein the volume percentage is as follows: under the normal temperature, Ar (argon) is 79%-80%, and CO2 (carbon dioxide) is 21%-20%; b) ensuring that the droplet transfer in the welding process is the spray transfer. The technical scheme has the following effects that the mechanical property of the welded joint is improved; the fusion zone performance is further improved; and the melting efficiency is improved,

				so that the impurity and the gas can overflow conveniently.
Water based welding anti-spattering agent for carbon dioxide arc welding	November 7, 2012/CN 102766383	Hefei Huaqing Metal Surface Treatment Co., Ltd.	Rao Dan	The invention discloses a water based welding anti-spattering agent for a carbon dioxide arc welding. The water based welding anti-spattering agent is composed of raw materials of, by weight, 40-45 parts of high polymer materials, 3.5-4.5 parts of flammable inhibitors, 4.5-5.5 parts of physical expanding agents, 0.2-0.5 part of antifoaming agents and the balance deionized water. On the basis of a high polymer material film formation mechanism, by means of screening and compounding of main components, such as the high polymer materials and other film formation auxiliaries, a water based product with the high polymer materials as main film formation substances is achieved, and the water based product is free of harmful substances of aromatic hydrocarbon substances and the like. When the product is sprayed on the surface of a welded part, a layer of protective film is formed on the spattering welded part surface in drying or wetting state, the contact between welding slag and welding materials is isolated, the adhesion is prevented, the operation is simple, and the time and effort are saved. The water based welding anti-spattering agent is suitable for the carbon dioxide arc welding of black metals, particularly suitable for occasions of various coating treatments after the welding is performed, and widely applied to machine processing and manufacturing enterprises of automobiles, shipbuilding, transformers, engineering machinery, containers, and the like.
Carbon dioxide arc welding method of high-intensity quenched and tempered steel	August 15, 2012/CN 102632322	Hunan Valin Xiangtan Iron and Steel Co., Ltd.	Qiu Fuxiang	The invention relates to a carbon dioxide arc welding method of high-intensity quenched and tempered steel, comprising the following steps of: (1) preheating before welding, wherein the preheating temperature is 90-110 DEG C, complex components need to be preheated to 140-160 DEG C, and the preheating method can be an oxy-acetylene flame heating method or an electrical heating method or a far infrared heating method; and 2) welding: adopting a CO2 gas arc welding process, wherein the welding thermal input is 8-10KJ/cm, the welding current is 200-240A, the voltage is 24-26V, the welding speed is 30-40cm/min, the protective gas is CO2, the gas flow is 14-18L/min and the interlayer temperature is 100-200 DEG C. By adopting the method disclosed by the invention, the welding joint has favorable tensile property, bending property and impact property and meets the production requirement of steel structures.
Welding device and carbon dioxide gas shielded arc welding method	August 9, 2012/US 20120199560	Era Tetsuo	Era Tetsuo	A welding device includes a power supply circuit for applying a voltage across a torch and a base metal, and a power supply control device. The power supply control device controls the power supply circuit such that a high level current is output during a first arc period Ta1 that is the initial period of an arc period, and an arc current corresponding to a regulated welding voltage is output during a second arc period Ta2 that is the latter period of the arc period. The power supply control device controls the power supply circuit such that a high level current is generated having a waveform increasing and decreasing at a constant frequency and constant amplitude superimposed on the high level current. By superimposing the waveform, the elevation of a droplet caused by an repelled force by the arc

				can be prevented, allowing a droplet to be formed in stabilization.

Exhibit 1 depicts patents related to carbon dioxide spot welding.

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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