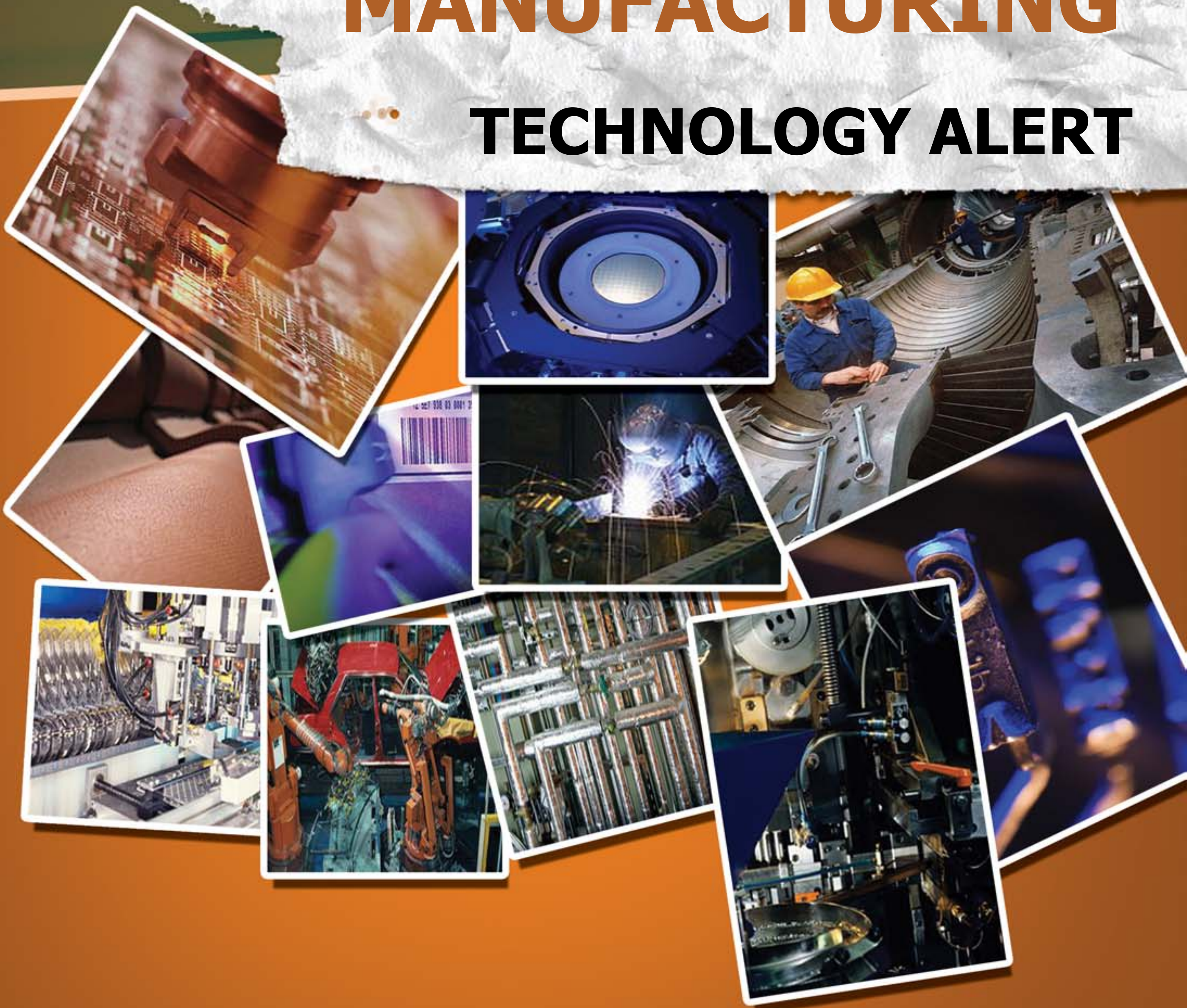
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



29th May 2015

1. MANUFACTURING PROCESS FOR PRODUCING SPECIALIZED OPTICAL FIBERS

A new method for manufacturing specialized optical fibers holds the promise of therapeutic interventions for patients suffering from a range of venous diseases such as varicose veins, thrombosis or other vein problems. Endovenous laser vein therapy is a procedure that uses a 0.5 mm thick optical fiber coated with plastic, which is sent to the site of faulty veins with laser light applied through the fiber. The laser light at the tip of the fiber and the heat from the laser (several hundreds of degrees C) cauterize and break down the faulty vein. For the laser to perform this highly precise task, its tip needs to be made reflective by tapering it with a cone-shaped indentation. Further, a glass gap is added to the fiber tip to ensure that no injury to the patient occurs from the fiber tip.

Scientists at the Fraunhofer Institute for Reliability and Microintegration IZM, Germany, have developed a novel automated process to manufacture high-precision optical fibers of 0.5 mm thickness, which would be used in the above-mentioned endovenous laser vein therapy. The team of scientists has successfully used the laser-fiber turning laser to easily manufacture the special optical fibers and the team claims that this new method could be used for automated production of optical fibers for the first time.

The research team explained that the research and development of this process and its automation took a considerably long time because of the complex processes (mechanical and manual processes) involved in making the fibers. This makes the process expensive as well, but the automation of the process ensures a consistent quality in the optical fibers. The research project is called LaserDELight project and is funded by the German Federal Ministry of Education and Research (BMBF).

The researchers shaped the optical fiber tip using a laser beam. The laser beam shaped the fiber tip in a cone-shaped indentation fashion. This approach to shape the fiber tip, the researchers explain, is more advantageous compared to the previous method of making the tip to have a tapered shape like a pencil tip. The bigger advantage of the cone shaped tip is that the protective glass cap added on the tip will be smaller than before. This makes the head of the optical fiber probe more robust, condensed and versatile. These new attributes of the fiber will in turn allow the fiber to be used in smaller vein branches.

The prototype of the new optical fiber produced using the novel process developed by the Fraunhofer scientists were demonstrated at the recently concluded measurements fair in Germany. Further to the successful working of the prototype, the scientists are now working to create fibers with more intricate diameters – in the order of 100 to 200 micrometers.

According to the research team, optical fibers with diameters of length 100 to 200 micrometers could open new possibilities in areas such as micro optics. The team reckons on a possibility of using micro optics for visible light communication (VLC) in very small areas using extremely fine optical fibers. In order to illustrate the possible application, one of the researchers explains an instance of using a fine optical fiber in a small and sensitive environment, such as, the human body. The fiber tip senses the environment and sends the data in the form of light to a detector. A photodiode or a complimentary-metal-oxide-semiconductor (CMOS) chip in the detector will interpret the optical signals into electrical signals.

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2. NOVEL SIMULATION TECHNIQUE FOR PRECISE HYDROGRAPHIC PRINTING

Hydrographic printing is a widely used industrial process for coloring surfaces of manufactured three-dimensional (3D) objects. This technique is used in many industries such as manufacture of automotive parts, toys, consumer electronics, and so on. This method has been very beneficial in coating surfaces of simple 3D objects. However, employing the same method for 3D objects with complex surfaces has been a challenge because the perfect alignment of the color patterns on complex surfaces is difficult to achieve.

A research team with members from Zhejiang University, China, and Columbia University, USA, has tried to address the pattern alignment problem on complex 3D surfaces in hydrographic printing by devising a new computational method to print appropriate patterns for complex 3D surfaces.

Hydrographic printing is used for coating color patterns on objects made of metal, plastic, wood, porcelain, and so on. In a typical hydrographic printing process, firstly, a desired color pattern is printed on a polyvinyl alcohol (PVA) sheet and the sheet is placed on the surface of water. In the next step, a spray consisting of activator chemicals is sprayed on the film to ensure the film stretches easily. Later, the 3D object is dipped into the water containing the floating PVC film. It is during the dipping that a crucial change occurs to the pattern that restricts application of the hydrographic printing technique to simple objects.

When an object with simple surface is dipped, the film comes in contact with the surface of the object and it stretches and sticks to the object's surface. The alignment of the pattern on the object is directly proportional to the stretch. However, when an object with a complex surface is dipped, the stretching of the film can be more and in some instances it may even tear the film. This makes alignment of the color pattern almost impossible to achieve on a complex surface. In fact, it is quite impossible to achieve perfect alignment even on simple objects.

The new method developed by the research team promises a near perfect alignment of color patterns through hydrographic printing not only for simple 3D objects but also for objects with complex surfaces. This method is an improvement on a computational technique previously developed by the Columbia Computer Graphics Group (Columbia University) for fluid and viscous sheet simulation. The research team has created a new and improvised viscous sheet simulation method to model the stretching of the color PVA film during the hydrographic printing process. This simulation method envisions the stretching and distortion patterns of color films based on the complexity of the object's surface. In addition, the simulation tool also creates a map between the spots on the surface and the locations on the film. Based on the map, the color image or pattern is created and printed on the PVC sheet for perfect alignment with the object's surface.

In order to demonstrate the new computational technique, the research team built an off-the-shelf hardware system in china. The hardware system consists of some mechanical equipment and a linear motor to accurately control the immersion of object over the film through water. The measurement of object orientation and the dipping location was done by a 3D system that was attached to the hardware system. Then using the new simulation system, the team was successfully able to print an appropriate color image/pattern on the PVA sheet for hydrographic printing process that delivers perfect alignment of the image on the 3D object.

Further, in order to eliminate the risk of extreme stretching or tearing of PVA sheet for complex structures, a multi-immersion design was incorporated. Using multi-immersion technique, the object will be dipped in different orientation each time with different color patterns rendering a complete and seamless pattern, perfectly aligned, over any complex surface.

One of the researchers on the team explained that this prototype system is currently designed for personal use and costs very less for setup and operation, as less as $0.40 per printing and can be used to print perfectly aligned patterns over the surfaces of an array of complex 3D objects.

The researchers are currently working on scaling-up the simulation method and associated hardware for real-time industrial use. At the industrial scale, this new technique can be employed to coat several complex and intricate structures manufactured in industries and in turn can save money considerably.

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3. INEXPENSIVE METHOD TO FABRICATE PEROVSKITE SOLAR CELLS

Climate change and its rather disturbing implications have pushed the world to look for energy sources that cause less harm to the environment. Many renewable energy sources have been researched in the past to meet the surging need for clean energy. Among the various renewable energy sources, solar energy always seems to take center stage because of its enormous potential to supply clean energy.

The technology of the photovoltaic cell, which harnesses solar power with equipment made from rather inexpensive and abundantly available silicon, has enabled solar technology to be adapted on a large scale, from homes to offices, public locations to large manufacturing facilities, and in many other places. Although inexpensive, the efficiency of silicon solar cells in converting sunlight to electricity in commercially available solar devices seems to have reached an impasse. The hunger for more clean energy has led universities, industries and many other stakeholders to explore for materials that have better efficiency than silicon in harnessing solar power.

A mineral made of calcium titanate, perovskite, is a material that has been found by researchers to show considerably good solar conversion efficiency in the recent times. Since its conversion potential was determined to be 14% in 2012, the material has shown an efficiency of up to 20% in recent research studies. This record increase of 6% in the solar conversion efficiency in just 2 years is the fastest advancement in solar technology recorded ever.

In what sounds like good news for solar cell manufacturers, a research team in Korea Research Institute of Chemical Technology, South Korea, has developed a method that not only produces more efficient perovskite solar cells but also costs less in comparison to the existing methods.

The new fabrication method developed in the South Korean university pushes the already existent efficiency of perovskite from 20% to 20.2%.

Unlike silicon, perovskite does not need several process steps or other facilities such as a clean room, extreme temperatures or vacuum to be made into solar cells. This essentially seems to save a lot of cost. The novel production process developed by the research team involves creation of formamidinium lead iodide (FAPbI3) perovskite, which is a type of perovskite with the broadest absorption capacity in the solar spectrum. The team's challenge was to produce films of FAPbI3 perovskite that are dense and uniform as these properties are crucial in making solar cells with highest possible efficiency.

The new process, as briefly explained by the researchers, involves a lead iodide–dimethylsulfoxide layer being placed in a formamidinium iodide solution—which results in the formation of formamidinium lead iodide perovskite crystals. In this process, FAPbI3 films are formed by the direct intra-molecular exchange of dimethylsulfoxide (DMSO) molecules intercalated in PbI2 with formamidinium iodide. The FAPbI3 films formed as a result of this process have a (111) – crystallographic orientation and are flat with no residues of lead iodide (PbI2). The research team claims that this novel method costs very less compared to any other existing method of fabrication.

Despite its high sunlight-to-electricity conversion efficiency, there are a lot of apprehensions about the perovskite solar cell's durability and efficiency in different environmental conditions over long periods of time. Some research studies have found that perovskite solar cells may have diminishing efficiencies over time. While this issue needs to be fixed for a sustainable growth of perovskite solar technology, the desirable efficiency of the technology has already made some start-up companies to offer sales of perovskite solar cells for commercial applications in 2017.

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4. PATENT ANALYSIS OF METAL INJECTION MOLDING

Metal injection molding (MIM) is an established manufacturing technology used for producing complex shapes from metals, in large quantities. The primary ingredient for MIM is metal taken in the form of power--typically the metal granule size in the powder is 20 micrometers or less. The powder is then mixed with binder to create the feedstock for the injection molding machine. After the mold is created, it is subjected to sintering process, where the metal part is given its final form and strength.

Usually metals such as iron, low-alloy steels, and stainless steels are used in the powder form for injection molding. Other metals including aluminum alloys, cobalt-based alloys, copper and copper alloys, nickel-based alloys and many more metals and alloys are being molded using MIM as well.

The advantage of the metal injection molding process is that it retains the properties of the metal or constituent metals in case of an alloy. Over the years, the MIM process has evolved to mold metals for various custom applications in fields such as automobile manufacturing, consumer goods manufacturing and many more. The ongoing research and development of new MIM processes and customization of existent MIM techniques for various applications come as no surprise given the high-quality parts produced by MIM techniques.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Method for bonding metal powder injection molded bodies	April 23, 2015; WO/2015/056513	IHI Corporation	Yoshizawa, Hiroki	According to this method for bonding metal powder injection molded bodies, a metal product is produced by: [1] bringing at least two metal powder injection molded bodies, each of which is obtained by kneading a metal powder and a binder and injection molding the kneaded material, into contact with each other; [2] applying a coating agent that contains nitrogen or chlorine to a bond part where the at least two metal powder injection molded bodies are in contact with each other; and [3] bonding the at least two metal powder injection molded bodies with each other at the bond part by means of degreasing or sintering. This bonding method is capable of improving the bonding strength at the bond part.
Method for manufacturing high strength alloy for metal powder injection molding	January 16, 2015; KR 1020150006215	Industry-Academic Cooperation Foundation, Yeungnam University	Baek, Eung Ryul	A method for manufacturing a high strength alloy for metal powder injection molding (MIM) is provided. The method for manufacturing a high strength alloy for metal powder injection molding comprises: a step of adding and blending Cu powder in Fe-2Ni-C-based alloy powder; a step of adding and blending a binder in the mixed metal powder; a step of powder-injecting the mixture; a step of degreasing the powder-injected molded object; a step of sintering the degreased molded object; and a step of heat-treating the sintered pellet. COPYRIGHT KIPO 2015
Binderless metal injection molding apparatus and method	December 1, 2014; KR 1020140136548	The Boeing Company	Wilkinson Carey E.	A metal injection molding apparatus includes a metal injection mold die having first and second die halves, a first set of features provided in the first die half, a second set of features provided in the second die half and complementary to the first set of features provided in the first are half and an ultrasonic transducer disposed in contact with the metal injection mold die. A binderless metal injection molding method is also disclosed.
Metal powder injection molded high-strength martensite aged steel and preparation method thereof	August 13, 2014; CN 103981436	Haian Eagle-Globe Powder Metallurgy Co., Ltd.	Shen Chengxiu	The invention relates to the technical field of martensite aged steel and preparation methods thereof and particularly relates to metal powder injection molded high-strength martensite aged steel and a preparation method thereof. The metal powder injection molded high-strength martensite aged steel contains the following ingredients in percentage by weight: 17-19% of Ni, 8-10% of Co, 4.5-6.5% of Mo, not higher than 0.08% of C and the balance of Fe and unavoidable impurities. The preparation method of the metal powder injection molded high-strength martensite aged steel comprises the following steps: adding a binder to the above powder materials according to a certain proportion to form a combination, mixing and milling the combination, crushing, injection molding, degreasing, sintering, carrying out solution treatment and ageing. By replacing a smelting production process with a metal injection molding process, three-dimensional irregular metal powder injection molded high-strength martensite aged steel structural parts can be manufactured through one-time molding; by adopting second-time solid-solution process treatment and ageing treatment, the metal powder injection molded high-strength martensite aged steel has the advantages that the tensile strength is over 1,500MPa, the elongation percentage is 10%, the impact strength is over 50J/cm<2>, and the hardness is HRC40-48.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Metal alloy injection molding	June 12, 2014; US 20140158317	Microsoft Corporation	Bornemann Paul C.	Metal alloy injection molding techniques are described. In one or more implementations, these techniques may also include adjustment of injection pressure, configuration of runners, and/or use of vacuum pressure, and so on to encourage flow of the metal alloy through a mold. Techniques are also described that utilize protrusions to counteract thermal expansion and subsequent contraction of the metal alloy upon cooling. Further, techniques are described in which a radius of edges of a feature is configured to encourage flow and reduce voids. A variety of other techniques are also described herein.
Multi-component composition metal injection molding	February 27, 2014; KR 1020140021443	McCullough Kevin A.	McCullough Kevin A.	A method of metal injection molding on a plastics injection molding machine having a heated barrel with an increasing temperature gradient is disclosed. The method comprises the steps of providing a metal alloy feedstock including a first metal alloy with a first melting point and a second metal alloy with a second melting point that is higher than the first melting point, the first metal alloy and the second metal alloy providing a gradient in composition of solids to liquids paralleling the temperature gradient of the heated barrel, feeding the first metal alloy and the second metal alloy into the plastics injection molding machine, heating the first metal alloy and the second metal alloy within the plastics injection molding machine to about 500-700° F./260-372° C.; and forming an equilibrium of about 5% to about 30% solids to liquids between the first metal alloy and second metal alloy within the heated barrel.
Degreasing subplate for metal powder injection molding	December 25, 2013; CN 103464755	Suzhou Mimo Metal Technology Co., Ltd.	Wang Quansheng	The invention relates to a degreasing subplate for metal powder injection molding. The degreasing subplate comprises two links arranged parallelly and a plurality of supports sleeved on the links in a sliding manner. Two ends of two links are sleeved with support posts. The supports are axially provided with drainage groove penetrating two ends of the supports. The degreasing subplate is simple in structure and capable of draining adhesive (grease) decomposed by a formed blank instead of retention, and clean can be performed conveniently; meanwhile, adjustable range is wide, accommodating space of formed blanks with various sizes can be met, and utilizing rate is increased greatly.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Metal injection molding method	November 28, 2013; US 20130315774	Cheng Chih-Wei	Cheng Chih-Wei	The present invention discloses a metal injection molding method, which is adapted to a mold having multiple mold cavities, and includes a feedstock preparation step, a molded articles ejection step, a classification and management step, a wax-based material removal step, a sintering step, and a compacting step. The classification and management step is to classify molded articles according to differences of the molded articles. The sintering step is to sinter the molded articles with sintering parameters. In this manner, tolerance caused by injection molding process is reduced because of the classification and management step and the sintering step, whereby further improving productive rate and quality of products produced from the mold with multiple mold cavities.
Binder and process for producing metallic or ceramic moldings in powder injection molding	March 14, 2013; US 20130062820	Johan Ter Maat	Johan Ter Maat	The invention relates to binders for pulverulent metals, metal alloys or ceramics based on polyacetals, polyethers and polyesters, to thermoplastic compositions comprising these binders for the production of metallic or ceramic moldings, to the use thereof and to processes for production of moldings therefrom.
Metal injection molding process	January 23, 2013/ CN 102886520	Nantong Jinjuba Machine Co., Ltd.	Cheng Jianping	The invention discloses a metal injection molding process. The metal injection molding process comprises the following steps that: a, an alloy powder raw material and an adhesive are weighed and then mixed based on a weight ratio of 30 to 50: 1; b, the binder is uniformly wrapped with the alloy powder raw material to form a feed by mixing; c, the feed is delivered into an injection molding machine and is injected into a mold cavity to form an injection molding blank; d, the adhesive is removed from the injection molding blank and is heated up by a thermal degreasing method to 400 to 600 DEG C within 0.5 to 1 hour, and the temperature is maintained within the range from 500 DEG C to 600 DEG C and then constantly maintained for 1 to 3 hours; and e, finally, sintering is carried out at 1000 DEG C to 1500 DEG C, and then a finished product is obtained after surface treatment. The metal injection molding part obtained by the metal injection molding process has quite low voidage, more than 96% of relative density and mechanical properties equivalent to a precise casting with the same compositions.

Exhibit 1 lists patents for metal-injection molding process.

Picture Credit: WIPO

The patents listed in Exhibit 1 reveal that there has been consistent invention of new injection molding process or process improvement of metal injection molding process.

The patent filed by Microsoft Corporation (US 20140158317) reveals a new method of metal injection molding for new alloys

An interesting patent filed for a metal injection molding process is by The Boeing Company (KR1020140136548) for a metal injection process that does not require any binding material.

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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Back to TOC