Advanced Manufacturing Technology (TechVision)

3D Printing in the Electronics Industry

"Three-dimensionally printing electronic components and devices"

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Contents

Innovations in 3D Printing in the Electronics Industry

3D-Printed Electronic Radar Parts

University of Massachusetts–Functional Conductive Ink Developed to 3D Print Electronics Parts

Tech. Profile

The functional ink developed by the researchers consists of tiny metal nanoparticles suspended in a thermoplastic polymer. The ink can be used for 3D printing and at the same time exhibits electrical properties that can be adjusted using different voltage levels. The special ink is very compatible with plastic and easily curable at low temperatures.

Competing Aspects

Many inks have been developed in the past which were used to 3D print electronics. These inks were difficult to control and to achieve the right electronic properties. When the printed essential parts involve radio waves and high frequencies, it is essential that the exact electrical properties are achieved.

Innovation Attributes

The research group has used the special ink to 3D print a reactor, also called as a voltage-variable capacitor used predominately in radar systems. The team also 3D printed a phase shifter used for steering the beam of a phased-array radar system . They used an aerosol jet 3D printer that employs steam gas to deposit the ink and a special 3D ink printer using vibrations to print the electronics.

Market Entry Strategies

The team is working on optimizing the performance and efficiency of the functional ink and various designs used to 3DP the electronics. They are also innovating new methods to integrate high-powered computer chips into the 3D printer manufacturing process.

Technology Readiness Level

1 2 3 4 5 6 7 8 9

Impact & Opportunities

Wide-scale Adoption

✓ This new innovation has opportunities for significant adoption by the end of 2020. This innovation is expected to find adoption in the military for manufacturing radar components and systems.

Market Opportunity

- Military
- Automotive
- Electronics
- Communications
- Aerospace
- Space
- Robotics

Technology Convergence

✓This new innovation can open a wide range of new application opportunities in the above industries. Electronics manufacturers can use this innovation to easily print electronics parts with integrated chips, circuits, and sensors. The method is easier and more economical for the manufacture of radar systems compared to conventional manufacturing methods.

3D-Printed Light Bulb

Graphene 3D Labs–"Romulus the Third" 3D Printer Capable of Printing Functional Electronics

Tech. Profile

Graphene 3D Labs, a 3D printing material provider, has entered the 3D printer market and filed a patent for a new printer called "Romulus the Third" which is capable of 3D printing functional devices such as light-bulbs, joysticks, batteries and other objects, by using different deposition techniques and materials.

Wide-scale Adoption

The company is still working on optimizing the printer to build precise functional devices and electronics. A focus area in 3D printing is to achieve production of 3D printed fully functioning electronics. With a partner, the prototype 3D printer could be commercialized around the end of 2017, with wide-scale adoption of this novel technology around the end of 2020.

Market Opportunity

- Commercial/Consumer Industries
- Electronics industry
- Robotics Industry
- Space Industry
- Automotive industry

Competing Aspects

There are many OEMs and research groups constantly innovating new techniques and methods in 3D printers which will be capable of directly printing functional electronics using various materials. At present, the Romulus the Third 3D printer can print certain functional devices and objects, which is a great advancement in the printer market.

Innovation Attributes

A 3D printer capable of directly printing functional devices and fully functional electronics with multiple materials, without stopping**. The patent also covers 3D printing of an organic LED light source.**

Market Entry Strategies

The company has decided to enter the 3D printer market with the "Romulus the Third" Printer and at the same time will also be concentrating on innovating and providing materials for 3D printing.

Technology Convergence

This new printer will open new and different application opportunities in the above industries. It can have a major impact on the electronics and the consumer goods industries as functional electronics and devices can be 3D printed directly**.**

Technology Readiness Level: 1 2 3 4 **5** 6 7 8 9

Smartphone 3D Printer

Prof. *Jeng Ywam-Jeng's Lab, National Taiwan University of Science and Technology– Smartphone-Based 3D Printer*

Tech. Profile

The smartphone-based 3D printer uses a new, developed photopolymer resin that can be hardened by visible light. Visible light emitted by the phone is used to cure the resin. A customized smartphone app is used to synchronize the smartphone screen and the printer motor, and allows users to load new designs for 3D printing.

Wide-scale Adoption

With improvements in print speed, via increasing the power of the smartphone's light, this smartphone 3D printer could witness wide–scale adoption by 2019.

Market Opportunity

- Wearable Devices Industry
- Electronics Industry
- Consumer Electronics Industry

Competing Aspects

The wearable electronics market is currently booming with new innovations. This smartphone 3D printer is wearable, cost-efficient, and easy to carry.

Innovation Attributes

As the photopolymer material flows inside the metal print-bed, the special resin is placed on the top of the phone for curing and sent to the printbed. The team was able to print an object with about100 microns thickness.

Market Entry Strategies

Jeng's Lab has decided to debut this new innovative device for a very affordable price; this will help increase the adoption rate and lead to a small 3D printer to be carried in one's pocket.

Technology Convergence

With a process to make the smartphone light more powerful, the new innovation, can find new applications in the above markets. The wearable devices and electronics industry might also implement the same technology in other devices and electronics.

Technology Readiness Level: 1 2 3 4 5 6 7 8 9

3D Electronics Printing

Voxel8–*3D Printer Capable of Printing Electronics*

Tech. Profile

The Voxel8 3D printer is capable of blending plastic, special conductive inks, and electronic components together to print a device. The special ink consists of conductive silver particles instead of the traditional carbon particles. This new ink is a thousand times more conductive than the carbon particle inks present in the market.

Wide-scale Adoption

The Voxel8 printer will be commercialized by the end of 2016 and can be expected to witness wide-scale adoption by early 2018.

Market Opportunity

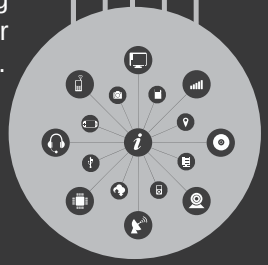
- Electronics
- Robotics
- Industrial Machinery

Competing Aspects

The printer uses a special ink to print electrical circuits with a layer resolution of 200 microns. The ink dries in just 5 minutes and other electrical components can be integrated within the 3D printed object. This printer is small in size and has a build envelope of 10 x 15 x 10 cm in size.

Innovation Attributes

The printer is capable of building objects with either PLA plastic or the special silver conducting ink. It has other features like Wi-Fi and USB connectivity to upload new designs and a 4.3 inch display touch screen, enabling an easy-to-use interface.



Market Entry Strategies

It is the only printer, which can print using the special ink which has a thousand times more conductivity than traditional inks. This will be the only printer in the market which will stop in-between the build process for the user to insert other electrical components.

Technology Convergence

The convergence between additive manufacturing and electronics will pave the way for new and different application opportunities. It can be anticipated that the electrical industry will slowly start to adopt additive manufacturing for design, development and rapid prototyping purposes.

Technology Readiness Level: 1 2 3 4 5 6 7 8 9

Analyst Perspectives
3D Printing Electronics

Innovation Ecosystem Strength

At present, there are few innovations in relation to 3D printing electronics. Many companies are researching and developing new methods and techniques to incorporate and implement additive manufacturing technology with electronics. Innovations in relation to 3D printing electronics is at medium intensity at present and is expected to gradually increase in the near future.

Target Markets–Near-, Medium- & Long- Term

- 3D printing electronics targets the electronics market and is expected to make an impact on this market in the near term.
- Since desktop 3D printers will be capable of 3D printing electronics, this technology will also impact the commercial/household 3D printing market in the medium term.
- This novel method of 3D printing electronics can be expected to be adopted by the robotics industry for designing, developing and rapid prototyping circuit boards and other low-volume components.

Driving Forces

- Additive manufacturing technologies are impacting many industries for various applications and are being widely adopted.
- Lead time reduction for manufacturing electronic devices.
- 3D printing technology provides more design freedom. Complex circuitry designs can be built easily.
- Designing, developing and rapid prototyping of a product can be done quickly and at the same time save development cost, time and man-power.

Entry Barriers

- A 3D printer capable of printing different electrical components is yet to enter the market.
- By using 3D printing, scalability and applicability for large-scale manufacturing of the product is difficult.
- 3D printers are not compatible with the traditionally used materials in the electronics industry.
- Multi-material printers are yet be designed and developed. Some printers are compatible with a maximum of three-four materials.

Competitive Landscape

- At present, most of the innovations and research is from the North American region. Many electrical OEMs and 3D printing companies have collaborated to implement 3D printing in the electronics industry.
- The European market is also actively researching new methods for 3D printing and also the materials which can be used for 3D printing.
- Though most of the patents have been filed in the APAC region, the intensity of adoption footprint of this novel technology is low compared to the other regions.

Key Patents

No.	Patent No.	Publication Date	Title	Assignee
1	CN104486910	April 04, 2015	Method used for manufacturing multi-layer circuit board by employing 3D printing technology	Anhui Neofound Technology Co., Ltd.
	The invention provides a method used for manufacturing a multi-layer circuit board by employing the 3D printing technology. The method is additionally provided with a heatproof insulation layer on the basis of an original printed circuit board. Raw material powder of the circuit comprises copper alloy powder and tin powder which are in a certain proportion, the heatproof insulation layer is ceramic powder, the 3D molding method is a laser irradiation molding method. During processing, the computer auxiliary manufacturing (CAM) technology is firstly utilized, circuit board design is accomplished on computer software and is transmitted to a 3D printer. The ceramic powder is fixed on the circuit board to form the heatproof insulation layer by utilizing the laser 3D printer, circuit molding of the powder is directly carried out on the heatproof insulation layer base body by utilizing the 3D printing technology, the steps above are repeated, and thereby the multi-layer circuit board is formed. Compared with a traditional printed circuit board, the multi-layer circuit board can be rapidly produced in a lab or under the small-batch production condition, moreover, the circuit does not easily generate defects, cost is low, response is rapid, equipment investment is small, and the method employing the 3D printing technology provides feasible small-batch customized production.			
2	CN104411122	March 11, 2015	Three dimension (3D) printing method for multilayer flexible circuit board	Fuzhou University
	The invention relates to a three dimension (3D) printing method for a multilayer flexible circuit board. The method comprises a first step of offering a baseplate material and materials of a metal conductor, wherein the baseplate material comprises polyimide, dacron powder and acrylic ultraviolet (UV) invisible glue, and the materials of the metal conductor comprise copper powder, cobalt-chromium alloy powder, gold powder and silver powder; a second step of printing the multilayer flexible circuit board from the lowermost layer, wherein each layer is printed through slitting layer by layer in a specific direction according to a 3D computer-aided design (CAD) model, each layer is printed firstly in x axis direction and then in y axis direction, printing starts from the vertex of top left corner of the lowermost layer, and the whole multilayer circuit board is printed firstly in x axis direction, then y and finally z. The 3D printing method can rapidly prepare the integral multilayer flexible circuit board, is simple, uses few materials and has high precision; furthermore, the 3D printing method can help lower manufacture cost of enterprises, and can realize change from volume production of the flexible circuit board to customized production.			

Key Patents

No.	Patent No.	Publication Date	Title	Assignee
3	CN104014790	September 03, 2014	3D ink-jet printer for printing electronic circuit board through ultrasonic atomization nanometer suspending liquid	Zhang Yuanming
	The invention discloses a 3D ink-jet printer for printing an electronic circuit board through ultrasonic atomization nanometer suspending liquid. The 3D ink-jet printer comprises an ultrasonic atomization nanometer suspending liquid device, a nanometer fine ink-jet printing device, an industrial positioning camera, a video monitor, an infrared laser micro-fusion-covering device, a heatable vacuum absorption workbench, a three-coordinate movable sliding table and a control portion. According to the 3D ink-jet printer, the nanometer suspending liquid to be printed is atomized based on an ultrasonic double-cavity atomization method, the nanometer suspending liquid is sent to a controllable nanometer fine ink-jet printing device through a guide pipe under the action of auxiliary gas and is directly printed on a substrate in a non-contact mode through a fine ceramic nozzle, the printed nanometer sizing agent is solidified and dried through the method of bottom plate heating or infrared laser micro fusion covering, evaporation of the solvent in the sizing agent, gasification of an organic clad layer and fusion of nanometer particles are accelerated, and therefore the electronic circuit board with high conductivity and micron-size line width is formed. The 3D ink-jet printer can directly print a conducting layer, an insulating layer, a protective layer and a solder mask and can print semiconductor components and parts.			
4	CN103481439	January 01, 2014	Forming method of 3D (three-dimensional) glasses plastic part embedded with FPC (Flexible Printed Circuit)	Shenzhen TCL New Technology Co., Ltd.
	The invention discloses a forming method of a 3D (three-dimensional) glasses plastic part embedded with an FPC (Flexible Printed Circuit). The forming method comprises the steps of providing a mould, wherein the mould at least comprises a rear mould, a first front mould and a second front mould; forming a first assembly by injection molding of the rear mould and the first front mould, wherein a groove is formed in the top surface of the first assembly; separating the rear mould from the first front mould to retain the first assembly on the rear mould, and assembling the FPC in the groove of the first assembly; compounding the second front mould and the rear mould for injection molding, and forming a second assembly on the top surface of the first assembly to integrate the first assembly and the second assembly so as to form the 3D glasses plastic part. According to the forming method provided by the invention, except for the top surface, other parts of the FPC are coated by the first assembly, and an impact force to the FPC is minimum in the process of forming the second assembly on the top surface of the first assembly, so that the production of the integrally molded 3D glasses plastic part embedded with the FPC by means of injection molding is realized, and the mechanical strength of the 3D glasses plastic part is ensured on the premise of maintaining good performance of the FPC.			

Industry Interactions

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