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ELECTRONIC INDUSTRY NEWS

Electronics Supply Chains Splitting Between China and U.S.

By Alan Patterson EE Times

Taipei – Foxconn, the world's largest contract manufacturer, says it plans to move more of its production outside China under the impact of the trade war between the world's two largest economies.

The announcement last week by the company that employs more than a million people in China assembling iPhones for Apple, servers for Dell and electronic games for Nintendo reflects a trend that's been gaining pace this year.

At an event called MIC Forum Spring in June, Foxconn Chairman Young Liu predicted in his speech that the pandemic, even after it's over, is likely to continue to affect the supply chains. A phenomenon generally known as "'the world's factory' no longer exists," he explained at that time.

During a Q&A session at the company's quarterly results on August 12, he made similar observations. "No matter whether it's India, Southeast Asia or the Americas, there will be a manufacturing ecosystem in each."

Taiwanese electronics manufacturers such as Foxconn, Quanta and Pegatron are leading a migration of production from China to new factories in Taiwan, Vietnam and India to cut costs and avoid U.S. tariffs while also addressing concerns surrounding security and intellectual property.

Foxconn plans to invest up to $1 billion to expand a factory in southern India, where the Taiwanese contract manufacturer assembles Apple iPhones, Reuters reported on July 11. Apple wants to move iPhone production out of China, the report said.

Protection of the global supply chain is important for companies such as Apple, Google and a range of high-tech companies, according to Richard Thurston, the former chief counsel for Taiwan Semiconductor Manufacturing Co. (TSMC). Taiwanese companies need to avoid U.S. criticism and potential U.S. penalties, fines, and trade restrictions related to possible export control violations, Thurston says.

Production of laptop PCs, which previously was all in China, will drop by half in the next three years, according to Digitimes Chairman Colley Huang, speaking at a July 29 event.

After three years, Vietnam will account for about 30 percent of total laptop production, followed by Taiwan with 20 percent and Thailand with about 15 percent, said Huang. He called the migration a “megatrend”.

Digitimes, which includes TSMC and other leading electronics companies in Taiwan among its founding members, provides information to clients on global supply chains and tech trends.

As multinational manufacturers shift away from China, the world’s most populous nation is backing the creation of its own integrated supply chain, according to Huang.

“China will try to build their own industry by themselves,” Huang said. “Over the past two decades, China welcomed multinational companies. But now in the coming years and decades, China will say no, it must be produced by Chinese.”

Some people say China and the U.S. may split their supply chains completely with both nations eventually making their own production equipment, software, semiconductors and systems.

“There will be two standards, now more so than ever,” says a fund manager with one of Asia’s largest sovereign wealth funds, speaking on the condition of anonymity. “China and the U.S. have lost trust in each other.”

“The U.S. can slow China down, but that’s futile in the long run unless the U.S. undergoes a major reboot,” according to the investor, who holds shares in major Asian tech companies such as TSMC.

With Digitimes, Huang is playing the role of an electronics ambassador for Taiwanese companies that are evaluating Asian nations for new production sites. He says he’s been meeting top-level government officials in the region to discuss potential investments.

One area of potential investment is automobiles. China makes about a third of the world’s automobiles for domestic and multinational companies such as Volkswagen and General Motors.

China makes about half of the world’s electric vehicles, and it will very likely continue to play a key role in the future, according to Huang. Six of the top-ten battery makers for electric cars are in China, Huang says.

“GM will to move to India, Vietnam and other countries, especially in Asia,” Huang says. He thinks Taiwanese companies should be able to help carmakers expand in Asia in the same way they built computer and smartphone supply chains in China.

Flat-Panel Displays

There’s one part of the electronics supply chain that shows few signs of breaking up.

Flat-panel displays (FPDs) are made in China, South Korea and Taiwan. China became the world’s largest maker nearly a decade ago after the Chinese government poured billions of dollars into companies such as BOE Technology that rapidly expanded production and caused a supply glut which impacted profitability for many of the incumbent producers such as Samsung Displays.

There are few signs that China will relinquish its hold on FPDs, which are used in military and consumer devices ranging from smartphones to air traffic control monitors.

"It is still just China expanding display capacity at the expense of other countries," says Ross Young, the CEO at Display Supply Chain Consultants. "We get rumours of potential projects in India from time to time, but they haven't panned out yet."

The multi-billion dollar cost of building an FPD facility is almost as daunting as that for a state-of-the-art semiconductor plant.

Building a new FPD manufacturing facility costs one to four billion dollars depending on the size of the display, motherglass, and technology.

"There is so little margin in building TV-sized liquid crystal displays that virtually all manufacturing is migrating from South Korea to China, and LG Display's new AM-OLED factory has just begun volume manufacturing in Guangzhou, China," says Kenneth Werner, principal with Nutmeg Consultants.

There's little hope for a Foxconn FPD plant in the U.S. state of Wisconsin that President Donald Trump once said would be the "eighth wonder of the world".

"Foxconn was going to build a Gen 10.5 fab in Racine County, Wisconsin," says Werner. "That was always a strange idea and is not going anywhere."

Exporting Science Parks

Huang says Taiwan may export its science parks that have helped incubate companies such as TSMC, United Microelectronics Corp. (UMC) and a host of other chipmakers and semiconductor design houses. Taiwan's two largest science parks are near the cities of Hsinchu and Tainan.

"The Hsinchu Science Park can go to India or Vietnam," he said. "Taiwan has to help emerging countries build their own industries."

The Taiwanese electronics companies that are present in every part of the global electronics supply chain ranging from semiconductors to finished systems are trying to reduce their exposure to the geopolitical struggle between the U.S and China that continues to escalate. Multinational companies that depend on the Taiwanese suppliers are concerned about the political risks they face, according to Stratfor Executive Vice President Rodger Baker.

"There are risks to the supply chain because the Chinese have the ability to use economic leverage to challenge companies in other countries that deal with or expand their behaviour with Taiwan," he said.

China considers Taiwan, which has governed itself independently for more than 70 years, a renegade province. China has not ruled out the possibility of taking Taiwan by military force.

Chinese military jets have been entering Taiwan's airspace on an almost daily basis in recent weeks. When United States Secretary of Health and Human Services Alex Azar made the highest-level visit in 40 years by a U.S. government official on August 3, Chinese jets again crossed into Taiwanese airspace in response.

China's navy has recently held manoeuvres in the South China Sea, which it claims as part of its territory. The exercises are seen as a threat to Taiwan's security.

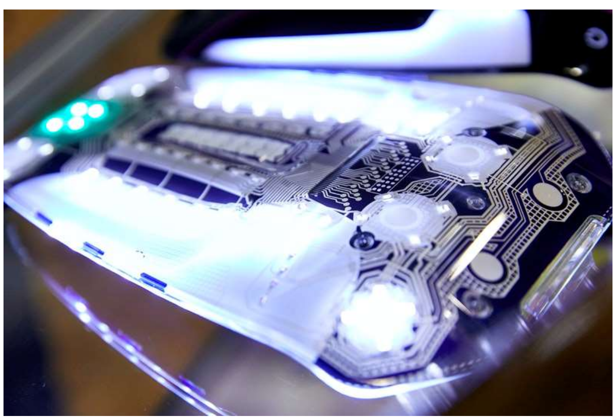
"They (the Chinese) have the ability to continue these large-scale military exercises and expanded types of military exercises that can add a sense of uncertainty," Baker said. "That sense of uncertainty can increase reinsurance costs. It can also make countries or companies start to rethink how much they want to be involved in Taiwan."

The world's splitting supply chains also have implications for TSMC's plan to invest in a new chip plant in the U.S. state of Arizona. The administration of U.S. President Donald Trump has been working for several years to close a deal with the world's biggest chip foundry. In the background are concerns that perhaps years from now, China will take over Taiwan.

"It's going to be a critical thing. If you want to continue to do business with the United States, you're going to have to make sure that the chips that you're using are not from the Chinese," Baker says. "And so TSMC becomes a really critical piece of that potential supply chain."

— Additional reporting by Judith Cheng, AspenCore Chief Editor, EETimes & EDN Taiwan/Asia.

3D Electronics: An Alternative to PCBs?



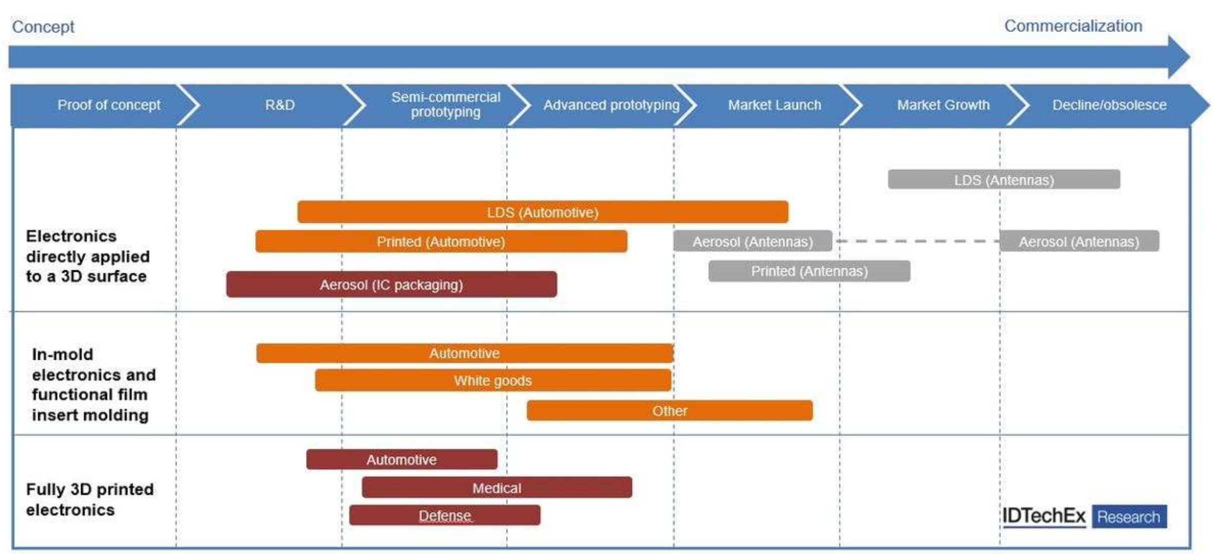
Mention an electronic circuit and you are likely to picture a printed circuit board (PCB): a rigid rectangle in a characteristic green colour with copper lines and a bewildering array of components soldered onto it. But does adding electronic functionality means using a PCB and thus requires shoehorning a rigid rectangle into the product?

The emerging approach of 3D electronics suggests not. Instead of making them separately on a rigid board, 3D electronics instead involves integrating electronic functionality within or onto the surface of objects. While antennas and simple conductive interconnects have long been added to the surface of injection-moulded plastic objects, 3D electronics is undergoing extensive innovation with new materials, metallization methods and manufacturing methodologies. This rapidly developing field is extensively analyzed in the new IDTechEx report, "3D Electronics 2020-2030: Technologies, Forecasts, Players".

Alternative Approaches

Electrical circuits are increasingly being added onto 3D surfaces and integrated within objects using a range of new techniques. While aerosol and material jetting enable conductive interconnects to be applied to surfaces, in-mold electronics and 3D printed electronics enable complete circuits to be integrated within an object. Between them the various approaches offer multiple benefits that include simplified manufacturing, reduced weight and novel form factors. With 3D electronics, adding electronic functionality no longer requires incorporating a rigid, planar PCB into an object then wiring up the relevant switches, sensors, power sources and other external components.

The new report from IDTechEx, "3D Electronics 2020-2030: Technologies, Forecasts, Players", provides an extensive overview of all approaches to 3D electronics informed by interviews with major players across the space. The pros and cons of each approach are weighed against each other for different applications, with numerous case studies showing how the different manufacturing techniques are deployed across the automotive, consumer goods and medical device sectors. Furthermore, through detailed analysis of the technologies and their requirements, we identify innovation opportunities for both materials and manufacturing methods. All the approaches and technologies analyzed in this report are shown below on a roadmap that shows their progress from concept to commercialization for different applications.



The status of different 3D electronics technologies for different applications, from concept to commercialization. For more details please see the IDTechEx report, "3D Electronics 2020-2030: Technologies, Forecasts, Players"

Electronics on a Surface

The best-established approach to adding electrical functionality onto the surface of 3D objects is laser direct structuring (LDS), in which an additive in the injection-molded plastic is selectively activated by a laser. This forms a pattern that is subsequently metallized using electroless plating. LDS saw tremendous growth around a decade ago and is used to manufacture 100s of millions of devices each year, around 75% of which are antennas.

However, despite its high patterning speed and widespread adoption, LDS has some weaknesses that leave space for alternative approaches to surface metallization. Firstly, it is a two-step process that can require sending parts elsewhere for plating, thus risking IP exposure. It has a minimum resolution in mass production of around 75 um, thus limiting the line density, and can only be employed on molded plastic. Most importantly, LDS only enables a single layer of metallization, thus precluding crossovers and hence substantially restricting circuit complexity.

Given these limitations, other approaches to applying conductive traces to the surfaces of 3D objects are gaining ground. Extruding conductive paste, a viscous suspension comprising multiple conductive flakes, is already used for a small proportion of antennas, and is the approach of choice for systems that deposit entire circuits onto 3D surfaces.

Aerosol jetting is another emerging metallization approach, in which a relatively low viscosity, usually conductive ink is atomized. This spray is then combined with an inert carrier gas and ejected from a nozzle. Aerosol jet has two notable advantages: it is capable of resolutions as fine as 10 um, and the nozzle can be placed a few mm away from the surface thus facilitating patterning of 3D surfaces with complex surface geometries. The downsides are the cost of the complex atomization and delivery process, and the requirement to re-optimize the process for different inks.

An advantage of digital deposition methods of the incumbent LDS technology is that dielectric materials can also be deposited within the same printing system, thereby enabling cross-overs and hence much more complex circuits. Insulating and conductive adhesives can also be deposited, enabling SMD components to be mounted onto the surface.

A comprehensive analysis and comparison of different metallization methodologies is given in this new report from IDTechEx, "3D Electronics 2020-2030: Technologies, Forecasts, Players".

In-mold Electronics

In-mold electronics (IME) offers a commercially compelling proposition of integrating electronics into injection-molded parts, reducing manufacturing complexity, lowering weight and enabling new form factors since rigid PCBs are no longer required. Furthermore, it relies on existing manufacturing techniques such as in-mold decoration and thermoforming, reducing the barriers to adoption. The basic principle is that a circuit is printed onto a thermoformable substrate, and SMD components mounted using conductive adhesives. The substrate is then thermoformed to the desired shape and infilled with injection-molded plastic. IME is especially well suited to human-machine interfaces (HMIs) in both automotive interiors and the control panels of white goods, since decorative films can be used on the outer surface above capacitive touch sensors.

While IME is likely to dominate HMI interfaces in the future due to the ease of manufacture and compatibility with established manufacturing techniques, it does bring technical challenges. Chief among these is developing conductive and dielectric materials that can withstand the temperature of the thermoforming process along with the heat and pressure of injection-molding. As such, materials suppliers are developing portfolios of materials aimed at IME, with conductive inks that can be deformed without cracking. Additional challenges include the development of electronic design software that can account for bending on circuits and developing SMD component attachment methods that are reliable under the molding process.

The applications and underlying technologies of in-mold electronics, along with the associated material opportunities, are extensively discussed in the recent IDTechEx report, "3D Electronics 2020-2030: Technologies, Forecasts, Players".

Fully 3D Printed Electronics

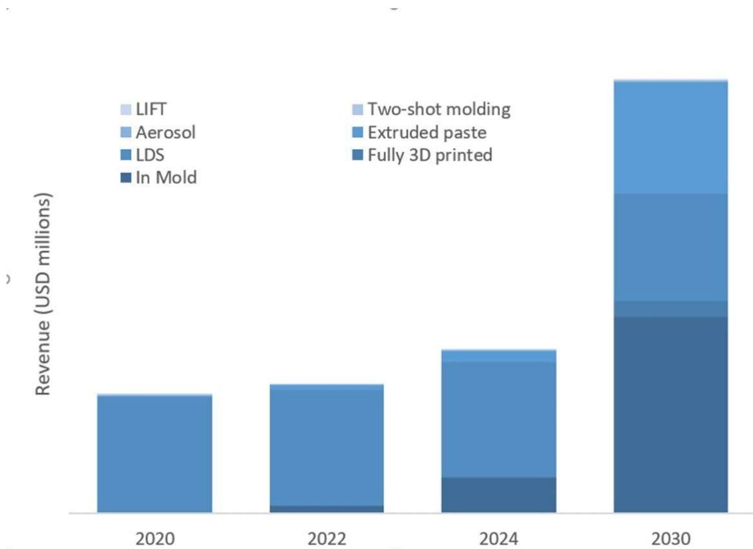
The least developed technology is fully 3D printed electronics, in which dielectric materials (usually thermoplastics) and conductive materials are sequentially deposited. Combined with placed SMD components, this results in a circuit, potentially with a complex multilayer structure embedded in a 3D plastic object. The core value proposition is that each object and embedded circuit can be manufactured to a different design without the expense of manufacturing masks and molds each time.

Fully 3D printed electronics are thus well suited to applications where a wide range of components need to be manufactured at short notice. Indeed, the US Army are currently trialing a ruggedized 3D printer to make replacement components in forward operating bases. The technology is also promising for applications where a customized shape and even functionality is important, for example, medical devices such as hearing aids and prosthetics. The ability of 3D printed electronics to manufacture different components using the same equipment, and the associated decoupling of unit cost and volume, could also enable a transition to on-demand manufacturing, in which objects with electronic functionality are

The challenges for fully 3D printed electronics are that manufacturing is fundamentally a much slower process than making parts via injection-molding since each layer needs to be deposited sequentially. While the printing process can be accelerated using multiple nozzles, it is best targeted at applications where the customizability offers a tangible advantage. Ensuring reliability is also a challenge since with embedded electronics post-hoc repairs are impossible - one strategy is using image analysis to check each layer and perform any repairs before the next layer is deposited.

Comprehensive Analysis and Market Forecasts

The IDTechEx report, "3D Electronics 2020-2030: Technologies, Forecasts, Players", discusses each approach to 3D electronics in considerable detail, evaluating the different technologies, their potential adoption barriers and their applicability to the different application areas. The report includes multiple company profiles based on interviews with major players across the different technologies. We also develop 10-year market forecasts for each technology and application sector, delineated by both revenue and area. We forecast the gradual decline of LDS and growth in extruded paste for consumer electronic antennas, and increased use of extrusion and aerosol, especially for automotive applications. The most substantial growth is predicted for IME, which we predict will be widely adopted in car interiors and the control panels of white goods.



Forecast revenue for various categories of 3D printed electronics (LIFT, aerosol, LDS, two-shot molding and extruded paste are all methods for adding electronics to 3D surfaces).

For more information on this report, please visit www.IDTechEx.com/3DElec or for the full portfolio of related research available from IDTechEx please visit www.IDTechEx.com/Research.

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