

The Power Electronics Industry Is Showing Steady Growth, Roadmap to address opportunities and challenges

The power electronics industry is a key part of the semiconductor history. According to the new market research report on the “Power Electronics Market by Material (Silicon, SiC, GaN, Sapphire), Device Type (Discrete, Module, and IC), Vertical (ICT, Consumer Electronics, Power, Industrial, Automotive, and Aerospace and Defense), and Geography – Global Forecast to 2022”, this market is expected to be valued at USD 41.73 billion by 2022, at a CAGR of 2.4% between 2016 and 2022.

The major factors driving the growth of the power electronics market include increasing demand for energy-efficient battery-powered portable devices, rising trend of energy harvesting technologies, enhancement of power infrastructure, and the growing focus toward using renewable power sources.

“The power electronics sectors continue to expand their presence almost everywhere,” announces Mattin Grao Txapartegi, Technology & Market Analyst at Yole. “Renewable energies and e-mobility, including EV/HEVs, are especially boosting this market. Both solar and EV/HEV converter markets grew by over 20% between 2015 and 2016.”

Rising demand for high power density in various applications is a major driver in the power electronics market. This demand is attributed by the various benefits offered by them such as less driving factor and simplified circuits which helps them to run at high power ranges. Design of compact power electronics are the best choice to use in high power density

products.

Among all the different types of power devices including thyristors, MOSFETs, IGBTs and power ICs, IGBTs made the greatest progress, with around 8% growth.

Usage of these devices in power systems helps in providing high flexibility, reliability and security which in turn helps ensure effective and continuous delivery of power. These devices play an important role in the adaptation of advanced networks and enhancement of power infrastructure instead of the current electrical grids. Growing demand for network reliability, increasing incorporation of power electronics in electrical grids, judicious use of energy and emphasis on reduction of biological pollution from the government are anticipated to propel the power electronics market growth over the forecast period.

Silicon expected to have the largest market size by 2022

Silicon accounted for the largest share of the power electronics market based on material segment in 2015. The growth of this market can be attributed to the applicability of silicon in various power electronics devices and products.

The power electronics market based on materials can be classified into silicon (Si), silicon carbide (SiC), gallium nitride (GaN) and sapphire. The major application of the solution would be in electric vehicles by using GaN semiconductor to replace electronics based on silicon, which are used as battery chargers and inverters. GaN semiconductors convert the battery power to help drive the electric cars. Silicon based electronic devices are used to restrain the power which limits the power handling capacity of the car.

The GaN semiconductors are cost affordable, easy to drive and improve the output power of electric cars, making them energy

efficient and lighter. Owing to these factors, the demand for GaN based semiconductor devices is increasing thus indirectly boosting the power electronics market. Presently, the U.S. is a leading consumer for electric cars. This is owing to strict emission rules made by the government in the region.

“Today, much power device novelty comes from a new family of WBG semiconductors, SiC and GaN”, says Ana Villamor Technology & Market Analyst at Yole. And she adds: “WBG benefits such as the performance and market needs accelerate their adoption in more and more applications. At Yole, we expect an increase of WBG market revenues reaching with over 30% CAGR between 2016 and 2022.”

Besides WBG devices, many other innovations are also emerging, as in power module packaging. Needs for higher power density and more highly integrated products have made some traditional technologies and materials outdated. Package evolution is responding to stricter requirements at the system level, and as ever here the automotive industry is driving innovation and growth.

Power IC market to grow at the highest rate during the forecast period

The power electronics market for IC based on device type segment is expected to grow at the highest rate during the forecast period. Increasing application of power ICs in radio frequency (RF), high-frequency wireless communication, radio detection and ranging (RADAR), satellite communication, electronic warfare, radio communication, and microwave radiation fields is expected to drive the growth of this market during 2016–2022.

Automotive vertical in power electronics to grow at the highest rate during the forecast period

The power electronics market for automotive based on vertical is expected to grow at the highest rate between 2016 and 2022. This high market growth rate can be attributed to the increasing adoption of energy efficient hybrid electronic cars because of the increasing concern over environmental pollution and saving energy.

US Power Electronics Technology and Manufacturing Roadmap

US Power Electronics Industry Collaborative (PEIC) has released US Power Electronics Technology and Manufacturing Roadmap. The report's lead authors are Keith Evans, president of PEIC, and Dave Hurst, formerly a market analysis expert at NextEnergy.

"Recent advances in power semiconductor technology, particularly in wide bandgap materials, have opened up significant new opportunities for the U.S. power electronics industry, along with corresponding challenges," said Keith Evans, PEIC president, in a statement. "The goal of PEIC's participation in creating the report was to identify those technology and manufacturing challenges, and to present key strategic recommendations for the U.S. to develop effective solutions to meet the growing demands for efficient power electronics."

While the need for innovation in semiconductors and passive components are two of the biggest challenges faced by the U.S. power electronics industry, the report also cites other roadblocks including a lack of strong power engineering

talent, competition from overseas manufacturers, cost pressures, and a need for manufacturing innovation.

Trend Analysis

According to report, the recent advances in power semiconductor technology have opened up new opportunities for innovation in power electronics. Market and regulatory conditions have created global demand for power electronics systems that take advantage of new semiconductor technologies to enable higher-efficiency devices that operate at higher temperatures, higher frequencies, and higher voltages in smaller packages and lower overall system cost.

Wide bandgap (WBG) semiconductor devices

Development of wide bandgap (WBG) semiconductor devices is a major component of the global innovation race in power electronics. WBG semiconductor devices, especially SiC and GaN-on-Si devices, are beginning to penetrate the market, although Si devices continue to dominate the industry.

The U.S. WBG semiconductor device manufacturing supply chain is more developed in SiC device technology, while GaN-on-Si devices tend to be manufactured in Asian foundries, leveraging the massive silicon device foundry infrastructure there.

In addition, next-generation WBG semiconductors like bulk GaN and so-called ultra-wide bandgap (UWBG) semiconductors like gallium oxide (Ga_2O_3), aluminum gallium nitride (AlGaN) and diamond are in aggressive development as they promise additional performance advantages over SiC and GaN-on-Si.

“To meet these demands at scale, several technological and manufacturing challenges need to be overcome. This roadmap provides an overview of these challenges, the current state of

the art, and emerging solutions to achieve these benefits. Emphasis is placed on understanding trends including interdependencies in semiconductors, capacitors, magnetics, and packaging technology. Using this information, this roadmap also presents key strategic recommendations for the U.S. to take advantage of these technological trends.”

Semiconductors are just one part of the overall power electronics system. While WBG and UWBG semiconductors are capable of operating at higher voltages and temperatures, today’s capacitors are not. Similarly, while WBG semiconductors are capable of operating at higher frequencies, today’s soft magnetics are not. Additionally, advances in packaging and thermal management are required before WBG semiconductors can be fully leveraged. The implication of improved semiconductor performance has ripple effects throughout the supply chain for power electronics.

Components

Components that support the overall power electronics systems, including capacitors, magnetic components, and packaging technologies are being pushed to match the new semiconductor performance levels, which in turn is creating market conundrums that are hampering growth of advanced semiconductors.

Current capacitor technologies struggle to match the high temperature performance needs, as existing capacitor technologies are limited by the properties of the dielectric used. Consequently, this presents a global innovation whitespace for the discovery and development of materials that exhibit the desired properties with reliability and durability that can meet a variety of applications.

Ferrites are the dominant form of soft magnetics used in power electronics systems today, primarily due to their low cost.

However, they are bulky and reducing their size requires higher frequency operation, which causes high losses. Amorphous alloys and nanocrystalline materials are being explored as potential solutions to this issue, but none of the materials developed exhibit the desired performance characteristics at a competitive cost yet.

Power electronics market based on devices is classified into BJT, IGBT, MOSFET, power diode and thyristor. The IGBT devices dominate the industry and are likely to continue the trend over the forecast period. These devices are widely used across the industry due to the features such as enhanced efficiency, faster switching, minimal power loss and ease of usage at high voltages. In addition, increased requirement for power electronics devices is likely to offer several opportunities to the players operating in the power electronics market, according to report by Global Market Insights.

New packaging techniques and materials are being developed to improve the performance of power electronics systems at high temperatures with improved reliability over many thermal cycles. These innovations focus on two critical areas of packaging, the die attach and the interconnection. In order to ensure reliability at higher temperature, new die attach techniques and materials are under development, including Silver-Tin alloy soldering, silver sintering, and embedded packaging. Current interconnection methods are also prone to failure and lose reliability at higher temperatures. New interconnection techniques are under development, including ribbon bonding, ball bonding, and embedded packaging.

APAC expected to hold the largest share of the power electronics market during the forecast period

Asia-Pacific (APAC) is expected to hold the largest share of

the power electronics market during 2016–2022. The high growth of this market can be attributed to the emergence of APAC as a strong manufacturing hub with leading manufacturers of consumer goods increasing their manufacturing activities in this region. Cost advantages and initiatives by different countries in this region are expected to boost the domestic manufacturing and provide further impetus for the growth of the power electronics market.

Moreover, the power electronics market growth in the region is accredited to the increase in power transmission, use of renewable energy and growing use of power electronics across the industrial sector. Technological developments in electronics, inverters, and UPS is boosting the regional power electronics market growth.

The report also profiles the most promising players in the power electronics market. The competitive landscape of this market presents an interesting picture where a large number of big and small players have become a force to reckon with. The key players in this market are Infineon Technologies AG (Germany), Texas Instruments, Inc. (U.S.), ON Semiconductor Corp. (U.S.), STMicroelectronics N.V. (Switzerland), Maxim Integrated Products, Inc. (U.S.), Fuji Electric Co., Ltd. (Japan), NXP Semiconductors N.V. (The Netherland), Qualcomm, Inc. (U.S), Vishay Intertechnology, Inc. (U.S.), Renesas Electronics Corp. (Japan), and Mitsubishi Electric Corp. (Japan).

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