What’s the biggest breakthrough in new material technology this year?

Kasey Panetta, Managing Editor

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Paul Kierstead, Director of Marketing, Cree SiC Power

With its proven ability to sustain high power densities in smaller devices, silicon carbide (SiC) material based power devices are now poised to replace silicon (Si) components, creating the potential to revolutionize energy efficiency and system performance in many types of power electronics systems. SiC power electronics devices feature markedly smaller die size for given power-handling capability than are possible using Si technology. Additionally, high power density unipolar SiC devices enable significant reductions in system switching losses versus their bipolar silicon counterparts with SiC MOSFETs and Schottky diodes replacing silicon IGBTs and PiN diodes in high voltage, high power applications. SiC technology has three major benefits: 1) Pure energy efficiency – simply replacing Si devices with SiC devices results in 1-3% higher energy efficiency. 2) SiC devices have inherently better thermal characteristics. Due to their enhanced energy efficiency and superior thermal impedance, SiC enables users to simplify and reduce the cost of their end systems with smaller, and more cost-effective thermal management components. 3) Higher switching efficiencies of SiC devices enable users to increase their system’s switching frequency while maintaining high efficiency. Higher frequency operation results in fewer and smaller magnetic and capacitive components improving system size, weight, and cost and reliability. With SiC technology rapidly approaching cost parity with silicon on a system level and SiC devices now offered in an ever-growing array of power ratings and packages, SiC is poised to revolutionize energy efficiency in systems including: solar inverters, servers, communications power, uninterruptible power supplies, trains, windmills, and heavy industrial power conversion.

Tom Colella, *Engineering Manager, Electrocube, Inc., www.electrocube.com*

Old materials are new again as companies scramble to replace polycarbonate dielectric as a primary material in capacitors. Invented by the Bayer Corporation in 1953 and produced beginning in 1958, the dielectric material was determined to have an operating temperature of -55ºC to +125ºC without derating. Its insulation resistance and dissipation factor were reasonable, and the size was small in comparison to other dielectrics. Due to its temperature range, polycarbonate dielectric was a preferred material for use in a variety of applications – including military. Since the economy's downturn, many in our industry have been understandably occupied. However, as of 2007, manufacturing of polycarbonate dielectric was discontinued leaving many to find viable alternatives for the material. Here's a quick guide to alternate capacitor dielectrics – replacements for polycarbonate capacitors.

Polyphenylene Sulfide (PPS): The closest dielectric to polycarbonate is polyphenylene sulfide (PPS). The temperature range, electrical parameters, and sizes are similar to polycarbonate.

Polypropylene (PP): The polypropylene dielectric is electrically superior to polycarbonate. The dissipation factor is low at 0.1%. The insulation resistance is high at 100K MegOhm/uf. Its major drawbacks are physical size and temperature range. The temperature range is -55ºC to +85ºC; derating to 50% at +105ºC. Polypropylene can be a very successful replacement as long as the application is within the temperature limitations. Applications include: coupling/decoupling, by-pass, power factor correction, snubber, filtering and energy storage capacitors.
Polyester (Mylar): The polyester dielectric (Mylar is the DuPont trade name) has been the workhorse of the industry for many years. The electrical parameters are somewhat lower than polycarbonate: the dissipation factor is 1.0%, and the insulation resistance is 20K MegOhm/uf. The temperature range can achieve +125ºC as long as the derating is met. The size is relatively smaller than polycarbonate. Successful polyester capacitors applications include: coupling/decoupling, by-pass and filtering applications.

Gordon Margulieux, ECN Reader

MIT has developed a new polymer film that can harvest energy from water vapor. No name yet, but any new materials used for energy harvesting will be big.

Steve McClure - Vice President Worldwide Sales and Marketing, Semblant

While super-hydrophobic coatings that repel liquid have been introduced to the market over the last couple years, market leaders now recognize that hydrophobicity alone will not protect an electronic device over time. The biggest breakthrough in new material technology is the introduction of conformal coat materials that use plasma deposition methods combined with material selection science to build on hydrophobicity. The result is a unique thin film barrier to prevent liquid damage and provide the most advanced protection from liquid yet. The availability of high-volume manufacturing plasma systems required to create the material also represents major breakthroughs in the n ew material space.


Jeremy Zelenko, Applied Materials Strategic Marketing Director

In a mobility age where smartphones and tablets are driving much of the electronics supply chain, chipmakers are looking for ways to satisfy the ever-increasing demand for faster and greater computational power for multi-functional mobile products. Even as the industry moves into the era of the high-k metal gate (HKMG) and FinFET transistor to meet this demand, chipmakers continue to seek ways to improve device performance without increasing power consumption. One of the biggest breakthroughs in new material technology this year is extending epitaxial deposition (epi) from PMOS to NMOS transistors.

Epi1 is an essential building block for high-performance transistors. It is selectively deposited in the source and drain regions and thus induces strain in the channel area which enables a significant gain in transistor speed. While in PMOS the strain is achieved by depositing Silicon with embedded Germanium, the NMOS strain is achieved by embedding smaller atoms such as Phosphorous and Carbon into Silicon.

The recently adopted high-volume use of selective epi in NMOS transistors at the 20 nanometer node enables chipmakers to achieve a 20 percent performance boost without increasing power current leakage. The increase in performance enables next-generation mobile computing capabilities such as multi-tasking, enhanced graphics and image processing and better responsiveness for an overall enhanced user experience.

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