Educational Initiatives in the Field of Dielectric and Semiconductor Materials, Devices, and Processing

by Durga Misra

The main objective of education in solid state science and technology areas is to prepare a highly skilled, innovative, creative, and adaptable workforce that can meet present and future challenges. Since the technology in this field has changed from microchip manufacturing to nanotechnology in only a few decades, it is imperative to examine the status of education in this area. Additionally, with many semiconductor companies going fabless in recent years, the status of education in dielectric and semiconductor materials, devices, and processing area have come under the microscope. This article summarizes the initiatives professional organizations, including ECS, are taking to foster advanced educational opportunities.

Advancement in technology in semiconductor industry requires a specialized workforce, and the lack of continuous education and retraining severely limits the necessary innovation and creativity. In addition, proper mentoring and industry-relevant research encourage bright minds to become technology leaders and drive tomorrow's innovations.

The emergence of nanotechnology brings a new dimension to education in solid-state science and technology. In a new manufacturing paradigm, a strong collaboration between the technology and design sciences is also required for co-optimization in order to create next generation high performance/low power devices. In addition, since the scaling limits are in the horizon for silicon devices, the concept "More than Moore," where functionalities that do not necessarily scale according to Moore's law, can become more pronounced. These functionalities include analog and mixed signal processing, the incorporation of passive components, high-voltage components, micro-mechanical devices, sensors and actuators, and micro-fluidic devices enabling biological systems (www.itrs.net). The integration of a new multidimensional knowledge requirement for innovation in next generation microchip fabrication dictates a new direction for advanced education. The progress in graphene-based devices and systems further dictates a different knowledge base for innovation and application of such systems, and it is a tremendous responsibility of universities and the professional societies like ECS to address the future educational challenges.

The Semiconductor Research Corporation, a consortium of academic programs and companies from the semiconductor industry, have an education alliance that provides funding for science and engineering undergraduate and graduate students with a unique education consisting of traditional coursework, cutting-edge research, and direct interaction with the semiconductor industry (www.src.org).

Education and advanced technological research helps the brightest minds to drive innovations and become technology leaders.

Fortunately, as a professional society, ECS assures the availability of adequate training and education of fundamental concepts to applied scientists and engineers in solid state science and technology. Both the Dielectric Science and Technology Division and the Electronics and Photonics Division have strong educational commitments. At every ECS meeting both Dvisions provide student travel grants so that graduate and undergraduate science and engineering students can participate in various symposia and/or student poster sessions. As part of the on-going "Tutorials in Nanotechnology" series, a tutorial on "Dielectrics in Nanosystems" involving dielectric science and semiconductor technology was offered during a 2011 spring meeting in Montréal. The topics were: (1) the perspective of nanotechnology and its convergence with future information technology; (2) status review of nanocrystals embedded high *k* nonvolatile memories; (3) Si nanowire FET technology; (4) the physics of nanonet fabrics and its applications in electronic, optical, biosensing, energy storage, and MEMS devices and systems; and (5) sensor systems for healthcare and homeland security. Experts from all over the world presented in this tutorial session. The tutorial, which was completely free for all attendees of the meeting, also provided an interdisciplinary approach to such educational outreach.

During the ECS 2012 spring meeting in Seattle a tutorial "More than Moore—Beyond CMOS Emerging Materials and Devices" is scheduled for all attendees, where many experts are set to present the tutorials in various topics. Some of the topics include (1) low frequency noise performance of state-of-the-art and emerging CMOS devices; (2) heterogeneously integrated III-V on silicon for future nanoelectronics; and (3) energy efficient computing technologies toward the end of silicon scaling. The Divisions also offer short courses in various science and technology topics during the ECS meetings on a regular basis, which are often directly related to industrial requirement in advanced technologies. Such courses aid in preparing professional engineers and graduating students to meet the requirement of high technology workforce.

In summary, ECS has responsibly brought advanced educational components in solid-state science and technology areas to its members and will continue the efforts as the technology advances.

About the Author

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