Setting the stage for vast improvements in semiconductors

Through cross-disciplinary research and cooperation with industry, Shanghai University researchers hope to move beyond the barrier set by Moore's Law.

Over the past 50 years, the number of transistors on integrated circuits (IC) has doubled about every two years, making devices like smartphones and computers cheaper and more powerful. This trend is known as Moore's Law. But scientists think the technology may have reached its limit and research institutes are moving past this trend and towards 'More than Moore' (MtM) technologies, where new functionalities are explored to provide further values to semiconductor chips, rather than just scaling.

One such institute is the School of Microelectronics (SME) at Shanghai University (SHU). Established in 2019, the college is dedicated to training scientists with the interdisciplinary capacity to design, manufacture and test ICs, and the ability to meet future challenges beyond Moore's Law.

"The development of the IC and semiconductor industry today requires collaboration of many fundamental disciplines, such as materials science, electronics science, chemistry, physics and mathematics," says Jianhua Zhang, a professor of microelectronics and executive dean of the SME.

SHU has a long history in IC development. In 1958, it was one of the first universities in Shanghai to establish an undergraduate semiconductor physics programme. In the years since, the university has formed a strong disciplinary foundation in microelectronics, electronic science, optoelectronic engineering, materials science and engineering, and other IC-related disciplines. In 2005, the Key Laboratory of Advanced Display and System Application at SHU launched a pilot line to carry on cross-disciplinary research and training on semiconductor display.

"Talent is very important," Zhang says. The point of SME's fairly recent establishment was to train top IC scientists and engineers. A problem in the past, according to Zhang, was that many graduates in the field could not immediately take up working roles because they were unfamiliar with industry needs, and the classes they took were too theoretical. The college is now focusing on the cultivation of cross-disciplinary talent and the cooperation between education and industry, "so that our students can be always in tune with industry needs," Zhang adds.

The SME has established school-enterprise cooperation with Shanghai Industrial μTechnology Research Institute (SITRI). SITRI's pilot line of 8-inch IC wafers allows students to participate in the whole process of chip design, manufacturing and testing.

As a local university in the Jiading district in the northwest of Shanghai, SHU is able to actively participate in the R&D of the adjacent automotive enterprises. The college is teaming up with car companies to develop artificial intelligence (AI) chips for smart driving, using heterogeneous integration — the integration of separately manufactured components — and ultra-high-definition display chips in the augmented reality (AR) head-up displays (HUD).

HUD is an optical technology that projects key driving parameters such as speed and direction on the windscreen. AR HUD dynamically merges these parameters with the real world to improve a driver's perception of the road, and reduce accidents. One of the major challenges the AR HUD technology encounters is processing and graphics alignment. Zhang describes it as "sense, store, calculate and display", which SHU is working to solve.

Zhang believes the research and application of new materials, and new technologies such as atomic fabrication and heterogeneous integration can open new areas for the IC discipline, solving technological bottlenecks. "The future technology update cycle may presently be longer than two years, but there is great possibility we can make it shorter. I am confident about this." ■

Artificial intelligence chips and augmented reality are advancing smart driving.

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