New materials for futuristic semiconductor memory devices
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The ultimate scaling limit of the semiconductor memory devices will be determined by the quantum mechanical effects, including tunneling of charges and non-classical distribution of constituent elements. Until then, the conventional device structure, such as the one-transistor – one-capacitor of DRAM and vertical-chain structure of NAND flash, will be retained. Alternatively, a disruptive technology could be pursued, which may include a vertically-stacked DRAM cell structure. For both cases, material innovation will be the key ingredient to sustain the scaling trends according to the Moore's law. In this talk, the new channel material for fabricating the ultra-low leakage current MOSFET, which may require only intermittent refresh in DRAM, will be discussed. Also, an extremely thin dielectric layer for a deep-sub-ten nm capacitor will be dealt with. For the vertical NAND flash scaling, a new charge storage mechanism would be necessary, which may suppress the cell-to-cell interference. In this regard, the newly discovered ferroelectric material could be a feasible contender to pursue a further increase in the integration density without increasing the stack height to an unfeasible value. For other resistance-based new memories, it will also be necessary to find the paths to stack them laterally, as in the present 3D X-point of Intel, or vertically, as for the vertical NAND flash. The talk will also cover some of the critical material aspects of such configurations of the new memories.
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Cheol Seong Hwang received a Ph.D. degree in 1993 in the Department of inorganic materials science and engineering, both from Seoul National University-Seoul, South Korea. In 1993 he joined the Materials Science and Engineering Laboratory of National Institute of Standards and Technology, MD USA, as a postdoctoral research fellow. Then, he joined Samsung Electronics as a senior researcher from 1994, made contributions to the fields of semiconductor memory. Since 1998, he has been a professor in the department of materials science and engineering at Seoul National University. He has authored or coauthored 609 papers in international journals and holds ~130 international/domestic patents. He is a recipient of many domestic and international awards, including the 7th presidential young scientist award of the Korean government, and AP Faculty Excellence Award, Air Products, USA, and Inchon Award. His current interests include materials for DRAM and NAND flash, new memory devices, ferroelectric materials and devices, and neuromorphic computing devices/materials. He is a member of the Korean Academy of Science and Technology, National Academy of Engineering of Korea, and a Fellow of Royal Society of Chemistry.