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Recent Advances in High k Gate Dielectrics for Nano-electronics

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Ultrathin dielectric layers on semiconductors have attracted much attention lately due to their importance in fundamental science and technological applications. One imminent application is found in the search of alternative high-κ gate dielectrics on Si replacing traditional SiO_2, an important and urgent challenge required by the Si CMOS technology roadmap in the next 3-5 years.[1] Questions often have been raised whether the Si/SiO_2 technology is coming to an end? Is there new competitive technology in the horizon? Toward this end we have undertaken the approach of molecular beam epitaxy with the ability to control the oxide/semiconductor interfaces on the atomic scale, which is the key to develop future electronic and even spintronic devices. This talk reviews the recent advances in the studies of ultrathin high κ dielectrics on semiconductors, and demonstrates the precision control of MBE growth of these nano-heterostructures superior to other techniques, thus has opened new exciting opportunities of nanoelectronic applications. Our research encompasses three major subjects: (1) MBE-grown HfO_2 high?κ gate dielectrics for Si nano CMOS, (2) thermal stability and electrical performance of high κ dielectrics integrated with metal gate for MOS diodes and MOSFETs, and (3) novel high?κ dielectrics for GaAs passivation.

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