Materials challenges for ultrathin gate dielectrics for CMOS and other applications

S. Guha, V. Narayanan, N. A. Bojarczuk, E. Gousev
IBM Thomas J. Watson Research Center,
guha@us.ibm.com
tel: 914-945-3835

There has been extensive activity in the past few years on high-k dielectrics in trying to replace the silicon dioxide gate dielectric used in Si based MOSFETs today. Identifying a replacement for silicon dioxide is one of the key checkpoints in order to continually sustain Si CMOS hyperscaling. As a result of this worldwide activity, today we are at a point where we clearly understand the problems that these replacement materials face. In this talk I will describe experiments that highlight some of these challenges: (i) temperature stability of metal oxide/Si structures, diffusion of metal into the silicon and mobility degradation; (ii) diffusion of oxygen in high-k metal oxides and interfacial oxidation at the silicon-high k interface; and (iii) challenges faced bythe different deposition techniques that are used for the gate dielectrics. As a spinoff of this research, I will also describe results on the growth of epitaxial dielectric oxides on silicon and the subsequent epitaxy of silicon on these oxides to create silicon quantum well based heterostructures and devices.
These results point to new possibilities for silicon-buried insulating epitaxial oxide based devices.