Toward Tinier Transistors: Scientists Probe New Semiconductor/Interlayer/Oxide Structure

Scientific Achievement

Measured energy band offsets in test transistors containing titanium oxide and a thin hafnium oxide "interlayer" added to increase the structure's performance

Significance and Impact

Helps explain effect of overall band offset on the performance of gate oxides, providing guidelines for developing thinner transistors than the silicon-based types currently commercially available

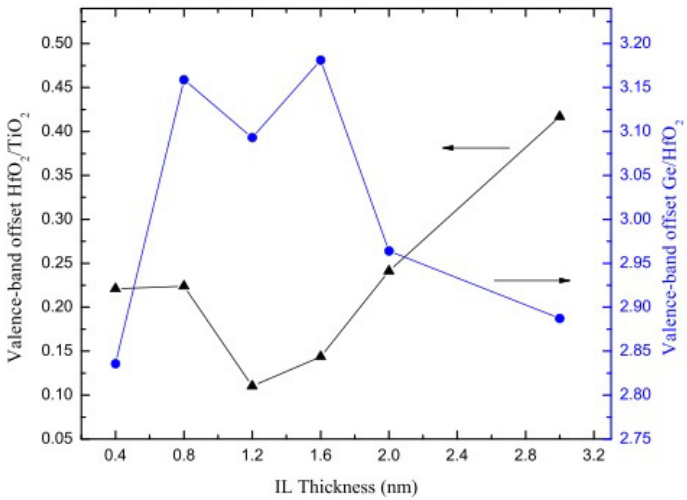
Research Details

– Created test structures of germanium (Ge), a hafnium oxide (HfO_2) interlayer, and titanium oxide (TiO_2)

– HfO_2 added to increase the structures' overall energy band offset, a property that prevents electrons from "leaking" between layers; Ge favored to replace silicon partly because charge carriers move much faster in it

– Using x-rays, discovered offsets changed as interlayer thickness was increased

– As new transistors must have interlayers thinner than 1 nm, work suggests that scientists need to be cautious when making assumptions about band offset



Band offsets for HfO_2/TiO_2 and Ge/HfO interfaces (black and blue lines, respectively) as a function of interlayer thickness, which ranged from 0.4 nm to 3 nm. The results show that the overall offset increases as the interlayer thickness is increased.

AK Rumaiz, JC Woicik, C Weiland, Q Xie, DP Siddons, GH Jaffari, C Detavernier, *Appl. Phys. Lett.* **101** 222110 (2012)

Work was performed at Brookhaven National Laboratory