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Functionalization of epitaxial $SrTiO_3$ on silicon via compensated B-site doping

$SrTiO_3$ is one of a handful of oxides that can be grown in single crystalline form directly on silicon. It was originally envisioned as a replacement gate dielectric for scaled CMOS technology because of its very high dielectric constant of ~300 at room temperature. However, one critical issue that prevented this technology to be developed is the zero conduction band offset with Si making it unsuitable for use as a gate insulator. Combined with the lack of any room temperature functionality in $SrTiO_3$, it is now mainly used as a buffer layer for growing other perovskite oxides on Si. In this talk, I will describe two means by which the $SrTiO_3$ layer on Si can be modified to achieve some functional utility in potential device applications, both being achieved by partial substitution of Ti with an acceptor cation while simultaneously compensating it with oxygen vacancies. In the first case, we replace Ti with Al, which causes a 0.3 eV increase in the band gap that is independently confirmed by spectroscopic ellipsometry and electron energy loss spectroscopy. Capacitor structures show a dramatic decrease in leakage current by six orders of magnitude, allowing $SrTiO_3$ to be useful as a gate dielectric on silicon. In the second case, we replace Ti with Co, resulting in a room-temperature ferromagnetic insulating state, with the magnetic moment arising from a Co^{2+}-oxygen vacancy complex. Such insulating ferromagnets are potentially useful for spintronics where it can serve as a spin filter for injecting spin polarized current into silicon. I will also briefly discuss first principles calculations that explain the mechanism of both the Al and Co substitutions into $SrTiO_3$.

Wednesday, November 13, 4:00 pm
Room 136 Jorgensen Hall

3:45 pm—Refreshments served in Jorgensen Atrium area

Host:
Dr. Xia Hong
Department of Physics & Astronomy

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