All Epitaxial Heterostructure for Spin Injection from a Half Metal into Silicon

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Using reactive molecular-beam epitaxy, epitaxial La0.7Sr0.3MnO3 / SrTiO3 / Si heterostructures have been grown. The SrTiO3 layer, just a few unit cells thick, serves simultaneously as a tunnel barrier and as a means to reduce reaction between the La0.7Sr0.3MnO3 and the underlying Si. The growth of La0.7Sr0.3MnO3 at MBE-compatible pressures requires ozone, which readily oxidizes bare Si and would destroy the chances for epitaxial growth. In contrast, epitaxial SrTiO3 can be grown on (001) Si using molecular oxygen via a complex, but established process. Once the SrTiO3 film is complete, ozone is turned on for the La0.7Sr0.3MnO3 growth. The thin SrTiO3 layer acts as a diffusion barrier for oxygen limiting the formation of SiO2 at the SrTiO3/Si interface. X-ray diffraction measurements show that the La0.7Sr0.3MnO3 layer has good crystalline quality with rocking curve full width at half maximum values of the 200 peak of less than 0.5°. Furthermore, electrical transport measurements indicate that the La0.7Sr0.3MnO3 layer is ferromagnetic and metallic below ~370 K with a resistivity <100 μΩ•cm at 4.2 K. Possible devices for tunneling spins into Si and for detecting spin carrier density inside a Si channel will be discussed.