Structural and Electrical Properties Of Tantalum

The objective of this research was to perform a systematic investigation of the unique structural and electrical properties of epitaxial graphene at the nanoscale. As the semiconductor industry faces increasing challenges in the production of integrated circuits, due to process complexity and scaling limitations, new materials research has come to the forefront of both science and engineering disciplines. Graphene, an atomically-thin sheet of carbon, was examined as a material which may replace or become integrated with silicon nanoelectronics. Specifically, this research was focused on epitaxial graphene produced on silicon carbide. This material system, as opposed to other types of graphene, holds great promise for large-scale manufacturing, and is therefore of wide interest to the academic and industrial community. In this work, high-quality epitaxial graphene production was optimized, followed by the process development necessary to fabricate epitaxial graphene nanoribbon transistors for electrical characterization. The structural and electrical transport properties of the nanoribbons were elucidated through a series of distinct experiments. First, the size-dependent conductivity of epitaxial graphene at the nanoscale was investigated. Next, the alleviation of the detrimental effects revealed during the size-dependent conductivity study was achieved through the selective functionalization of graphene with hydrogen. Finally, two techniques were developed to allow for the complementary doping of epitaxial graphene. All of the experiments presented herein reveal new and important aspects of epitaxial graphene at the nanoscale that must be considered if the material is to be adopted for use by the semiconductor industry.
Here, we report on the effects of dopant concentration on the structural and electrical properties of In-implanted Ge. For In concentrations of ≤ 0.2 at. %, extended x-ray absorption fine structure and x-ray absorption near-edge structure measurements demonstrate that all In atoms occupy a substitutional lattice site while metallic In precipitates are apparent in transmission electron micrographs for In concentrations ≥ 0.6 at. %. Evidence of the formation of In-vacancy complexes deduced from extended x-ray absorption fine structure measurements is complimented by density functional theory simulations. Hall effect measurements of the conductivity, carrier density, and carrier mobility are then correlated with the substitutional fraction.

Colossal magnetoresistive (CMR) compounds with the perovskite structure are mainly characterized by a competition between ferromagnetism and paramagnetism, and between a metallic and insulator behavior. Electrical and structure have been studied in La$_{1-x}$Sr$_x$MnO$_y$ (x = 0.1, 0.15, 0.2, 0.25, 0.3, 0.35). The magnetoresistance was determined by measuring the temperature dependence of resistivity under a magnetic field 0.5 T. It was negative for all compositions and significantly influenced by the Sr content and annealing time. The obtained magnetoresistance values may make the materials promising for different applications.