Public Abstract

There has been great recent interest in the development of electronic-type devices that exploit not only an electron's charge, but also its spin. Such "spintronic" devices hold the promise of higher stability data storage, increased processing speed, and decreased power consumption as compared with conventional electronics. Many potential spintronic devices will require a "spin injector" capable of producing a current in which almost all the electrons have their spins aligned in the same direction. In particular, it would be valuable to develop a *ferromagnetic semiconductor* spin injector that could spin-polarize electrons with its magnetic field, and is compatible with semiconductor materials common to existing electronic devices. A promising candidate for such a spin-injector is $Ga_{1-x}Mn_xAs$, due to its relatively high ferromagnetic transition temperature (T_C), and its compatibility with standard GaAs. However, in order to achieve maximum T_C, $Ga_{1-x}Mn_xAs$ must be carefully annealed after growth. While it has been known since 2001 that annealing can increase T_C, it has not been understood until very recently exactly how annealing achieves this benefit.

With the aim of better understanding the annealing process, this dissertation's primary focus is polarized neutron reflectometry experiments that examine how annealing changes the depth-dependent properties of $Ga_{1-x}Mn_xAs$ thin films. For several uncapped films, annealing is observed to significantly alter these films' chemical and magnetic depth profiles, while annealing is observed to do little to a sample capped with GaAs. These results provide evidence that annealing enhances $Ga_{1-x}Mn_xAs$ by ripping ferromagnetically disruptive Mn impurities from the crystal lattice, freeing them to migrate to the surface of the film - corroborating other recent work.