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MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF LaNi_{x}Fe_{y}

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Rare earth-iron intermetallics are still the best candidates for the next generation of economically feasible high performance permanent magnetic materials. In spite of several decades of research dedicated to understanding the magnetic interactions in these materials, several aspects remain poorly understood. Recent developments in spin resolved photoemission spectroscopy provide an opportunity to investigate, in unprecedented detail, a poorly understood aspect, the relationship between the electronic band structure and the bulk and microscopic magnetic properties. However, interpretation of spin-resolved photoemission spectra of complex intermetallics is very difficult. Consequently, it is prudent to study relatively simple systems such as RM, (R = rare earth, M = transition metal), which is the building block of more complex intermetallics such as RM_{1-x}Fe_{x}, because if simple intermetallics do not exist, one must study an iron doped RM system such as LaNi_{0.69}Fe, in order to obtain information about the contribution from the iron sub-lattice to the band structure.

For best results, it is desirable to study samples with large amounts of iron. Iron concentrations of samples used in early studies of LaNi_{0.69}Fe were limited to about x = 1.2 but concentrations as high as x = 1.7 have been recently achieved using somewhat tedious processing techniques. Herein, we report the crystallographic and magnetic properties of a series of induction melted LaNi_{0.69}Fe samples prepared from 99.99 percent pure elements by induction melting in a cold crucible followed by annealing at 950°C for 120 hours. The phase purity of the samples was checked by x-ray diffraction using Cu Kα radiation on a Scintag XDS 2000 x-ray diffractometer equipped with a single crystal graphite monochromator. The bulk magnetic properties of the samples were measured at the Southern Illinois University-Carbondale on a Quantum Design SQUID magnetometer. The powder neutron diffraction data were obtained at the University of Missouri Research Reactor for samples placed in thin-walled vanadium containers and exposed to 1.4875 Å neutrons for 4-6 hours each at 30 and 295 K. The spectra were refined by the Rietveld technique.

Figure 1 shows thermo-magnetic data for three of the samples. The data for x = 1 and x = 1.2 sample are in good agreement with prior work. Increasing the iron content from x = 1.2 to x = 1.35 increases the Curie temperature by another 25 degrees. However, saturation magnetization is affected only marginally by the increase in the iron concentration.

Neutron diffraction patterns for all of the samples could be fit based on the CaCu_{2} type structure (space group P 6/mmm). Figure 2 shows the neutron diffraction pattern measured at 30 K for LaNi_{0.69}Fe along with a fit based on the CaCu_{2} type structure. The unit cell expands isothermally with increasing iron content such that the cell volume of LaNi_{0.69}Fe_{1.14} is 3.4% larger than that of LaNi_{0.69}. Refined occupancy factors indicate that approximately 99% of the iron atoms occupy the 3g transition metal site.

Analysis of bulk magnetization data and magnetic moments obtained from neutron diffraction data reveals that Ni atoms possess an induced magnetic moment.

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