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Magnetic and structural properties of $Ni_{1-x}Fe_xAl$ alloy films

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Rapidly evolving field of spintronics stimulates a deep interest in ferromagnetic metals with the full spin polarization at the Fermi level. These so-called half-metallic ferromagnets are favorable candidates for the electrodes for spin-polarized current injection into semiconductors. A significant number of intermetallic semi-Heusler and true Heusler alloys (HA) have been predicted theoretically to be half metals and their films can be used as spin injectors in such devices. In this study, we investigated the magnetic and the structural properties of ternary $Ni_{1-x}Fe_xAl$ alloy films, from the semi-Heusler to the true Heusler composition range. The alloy films were grown at the novel deposition conditions by using an ultrahigh vacuum dc-magnetron co-sputtering system. The structural and the magnetic properties were investigated by x-ray diffraction and vibrating sample magnetometry, respectively. It was found that the structures of films depend strongly on the composition. A film for $x = 0.35$ exhibits two different structural phases, one is the Ni_3Fe phase and the other is the ternary alloy phase. Films for $x = 0.5$ and 0.7 are, however, only in the ternary alloy structure. It was also found that the magnetic moment for films is increased monotonically with increasing the Fe contents, and all the samples exhibit a magnetic anisotropy. These results were further discussed in connection with the structures and the magnetic anisotropy energy of the alloy films.