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A comparative study of Mn-containing Heusler alloys

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Recently, Mn-containing Heusler alloys attract a wide interest owing to their potential in magneto-mechanical applications. In this study, the structural and the magnetic properties of Ni_2MnZ ($Z = \text{Al}, \text{Ga}$ and In) Heusler alloys were comparatively investigated. The bulk alloys were prepared by using an arc-melting technique, and the thin films were fabricated on glass substrates by using flash evaporation. Two distinct substrate temperatures (150 and 730 K) were chosen to prepare the alloy films with significantly different atomic orders. The structural characterization of the bulk alloys and the thin films has been performed by normal and grazing-incidence x-ray diffraction, respectively. The structural properties of the films were analyzed in connection with those of bulk alloys. The optical properties were investigated in an energy range of 1.05 - 4.0 eV, and the optical-conductivity spectra of the bulk alloys and the ordered alloy films exhibit two peaks. The temperature dependence of magnetization, $M(T)$, of the bulk and the thin-film Ni_2MnGa and Ni_2MnIn alloys were investigated in the 5 - 394 K temperature range for zero-field cooling and field cooling in an external magnetic field of 100 G. While the ordered films exhibit nearly the same ferromagnetic behavior as the bulk Ni_2MnGa and Ni_2MnIn alloys, the disordered films turn out to be nonmagnetic. It was found that an annealing of the disordered film restores its crystallinity and also recovers the ferromagnetic order. These results are further discussed in connection with the theoretical electronic structures.