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## Structure and magnetic properties of Ni-Mn-Ga thin films deposited by dc-magnetron sputtering

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Recently, Ni<sub>2</sub>MnGa Heusler alloys have been intensively investigated owing to their ferromagnetic shape-memory effect. Even though the previous studies generally show that excessive Ni and Mn can enhance the martensitic transformation temperature ( $T_M$ ), the origin of the enhancement in  $T_M$  is still unclear. Hence, in this study, the structural and the magnetic properties of off-stoichiometric Ni-Mn-Ga films were studied. The Ni-Mn-Ga films were fabricated on Si substrates by using an ultrahigh-vacuum dc-magnetron sputtering system. Several substrate temperatures were chosen to prepare the films. The composition of films was confirmed by electron-probe micro-analysis. The structure of Ni-Mn-Ga films was characterized by x-ray diffraction. The vibrating-sample-magnetometer measurement was carried out to investigate the magnetic properties. The films, deposited at room temperature, 100 and 200°C, show very small saturated-magnetization values. On the other hand, the magnetization increases greatly when the deposition temperature increases from 200 to 400°C. However, a paramagnetic behavior was observed for the film deposited at 500°C. This phenomenon may be due to the altered structural properties. It is common that the presence of nonmagnetic and/or antiferromagnetic phases (such as NiMn phase) weakens the ferromagnetic properties which comes from the NiMnGa phase. At 500°C, the crystalline structure of film was decomposed into several phases, leading to the paramagnetism.