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Structural and Magnetic Domains in Ni2MnZ Heusler Alloys

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NiMn-based Heusler compounds show a variety of interesting functional properties such as the ferromagnetic shape memory effect or the magnetocaloric effect. The room
temperature ground state structure is $L2_1$ order, while at higher temperature a state of increased entropy is preferred, corresponding to B2 order. Quenching a crystal from the B2 stable regime preserves its disordered structure while going to low temperatures, where atomic diffusion is inactive. During subsequent annealing, $L2_1$-ordered domains nucleate independently and grow, leading to a division of the crystal into anti-phase domains (APDs) [1].

The magnetic moments are mainly carried by the Mn atoms, which interact ferromagnetically in the $L2_1$-ordered state. However, it has been found that at structural anti-phase domain boundaries the magnetization tends to reverse, leading to atomically sharp ferromagnetic domain walls [1]. To study this interplay of magnetic and structural order as well as the mechanism of coupling of ferromagnetic domains across APD boundaries, we have investigated Ni_2MnAl and $Ni_2MnAl_{0.5}Ga_{0.5}$ powder samples in distinct ordering states via temperature-dependent small-angle neutron scattering (SANS) as well as neutron powder diffraction, giving access to the magnetic and the structural microstructure. Further, we reproduce the correlation between structural and magnetic order by Monte Carlo simulations.

[1] H. Ishikawa et al., Acta Mater. 56, 4789 (2008).

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