Influence of annealing temperature on magnetism and defects in $Mn_{2.4}Fe_{0.8}Al_{0.8}$ alloys

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Manganese-based alloys with the composition Mn_2FeZ, Z = Si, Al, have been widely investigated in recent years due to their potential applications in spintronics. Mn_2FeSi alloy already prepared in the form of ingots, thin films, powders or ribbons exhibits a cubic full-Heusler ($L2_1$) or inverse-Heusler (XA) structure or combination of both [1]. Contrary, the Mn_2FeAl alloy has so far only been prepared in the form of an ingot and owns a primitive cubic (β-Mn type) structure [2]. Present investigations are devoted to the $Mn_{2.4}Fe_{0.8}Al_{0.8}$ ingots prepared by induction melting technique and additionally annealed for 5 days at 773 K and 1073 K in the argon protective atmosphere. Their microstructural, defect, and magnetic properties are studied in dependence on annealing temperature and compared to the Mn_2FeAl alloys. The scanning electron microscopy completed by the energy dispersive X-ray spectroscopy confirmed single phase alloys with compositions slightly different from the nominal one (about 57.5 at.% Mn, 20.5 at.% Fe, and 22.0 at.% Al). The X-ray diffraction analysis revealed the origin of β-Mn structure with the lattice parameter of 0.636(1) nm well comparable with the value of 0.637(3) nm obtained for Mn_2FeAl ingot [2]. Results of positron annihilation spectroscopy showed that vacancy concentration in both Mn_2FeAl and $Mn_{2.4}Fe_{0.8}Al_{0.8}$ ingots is very low and almost all positrons are annihilated in the free state. Coincidence Doppler broadening measurements indicated that the alloys with increased amount of Mn have higher contribution of positrons annihilating near Mn. Magnetic properties of Mn_2FeAl alloys showed an antiferromagnetic-paramagnetic transition with the Néel temperature about 36-37 K without essential impact of annealing temperature. Similar magnetic characteristics are observed for $Mn_{2.4}Fe_{0.8}Al_{0.8}$ ingots in as-cast state and after annealing at 773 K. Contrary, the sample annealed at 1073 K exhibited a weak ferromagnetic contribution at room temperature and its influence increased during cooling down to 5 K.

References:

[1] A. Aryal et al., Journal of Alloys and Compounds **823**, 153770 (2020)

[2] S. Dash et al., Journal of Magnetism and Magnetic Materials **513**, 167205 (2020)

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