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About the order-disorder transition in arc melted Fe_3SiAlx soft alloys

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There is an increasing interest in soft magnetic Fe-Si-Al alloys due to their promising properties for applications in various fields; however, all these structural and magnetic properties depend on the structure of the composition alloys The Fe-rich side of the phase diagram of the Fe-Al, Fe-Si and Fe-Al-Si systems presents the same structures; at room temperature, Fe-Al system is characterized by a wide range of ferromagnetic disordered body centered cubic solid solution (A2) up to 22 at.% Al at room temperature. On increasing the Al content, the first intermetallic structure is Fe_3Al with $D0_3$ cubic structure and it exists over the 18-32 at.% Al range. The other stable intermetallic structure is FeAl, which is also cubic with B2 structure (CsCl) and it exists over the range 32-50 at.% Al. The magnetic behavior of ordered Fe-Al alloys is complex in the 27 to 32 at.% Al region where the magnetization actually decreases with decreasing temperature. It was found that partial substitution of Al by Si leads to significantly improved $D0_3$ structural stability against ordered B2 structure and disordered A2 structure. Moreover, there have been extensive studies, both experimentally and theoretically, of order-disorder transitions of Fe-rich ternary alloys. Mutual solid solubility between Fe_3Al and Fe3Si is well-established. The solid solubility and the magnetic behavior of $Fe_3(Al,Si)$ was correlated with the ratio of electron-atom . Polishchuk and Katsnel´son studied the existence of the ordered phases $\alpha 1$ (Fe_3Al and Fe_3Si which have $D0_3$ or BiF_3 type order) and α_2 (FeAl and FeSi which have B2 or CsCl type order) along the Fe_3Al-Fe_3Si section by means of high temperature X-ray diffraction and recording the disappearance of $D0_3$ superlattice (111) and (200) reflections as a function of temperature and composition. In this work, alloys of nominal compositions of sendust Fe_3SiAlX (X =1, 0.75, 0.5, 0.25). The phase purities of the arc-melted ingots were studied by x-ray diffraction using a Rigaku D-MaxB X-ray diffractometer with Cu-Kα radiation. It was found that decreasing Al leads to more disorder in the alloy by the formation of α-Fe solid solution. However, the addition of Al influences both of the lattice parameter and crystallite size of the Fe_3Si phase. Results show that the presence of α_1-$Al_{0.3}Fe_3Si0.7$ with a (422) preferred orientation has been noticed over the 70 at% Fe range.

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