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Investigation of atomic ordering processes in the bulk and surface layer of Fe-Ga alloys

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Fe-Ga compounds show high magnetostriction values depending on Ga content and thermal treatment. The physical cause of the giant magnetostriction effect is still not clear despite more than 20 years of research. The alloys have a complex phase diagram, which continues to be investigated by various methods, including electron, neutron, X-ray and synchrotron radiation diffraction. In a number of papers [1, 2, 3] exotic crystalline phases with L60 and D022 structures were observed by the experimental techniques with a small penetration depth (X-ray and electron diffraction). These phases with tetragonal symmetry in principle may be responsible for the occurrence of the giant magnetostriction in the Fe-Ga alloys.
We carried out an extensive study of these alloys using all the previously listed methods and found that the phase composition of the surface and of the internal volume of the cast Fe-Ga alloy sample may differ, which directly affects the results of the phase analysis. When studying bulk samples by different methods minimizing the contribution from the material surface, no additional phases were observed. The defects in the ordering of atoms are present in the surface layer, which influence diffraction patterns and may be interpreted as new phases with L60 and D022 structures. Due to their small volume compared to the materials bulk, these phases do not affect the occurrence of magnetostriction.

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