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Epitaxial mosaic-like Mn_5Ge_3 thin films on Ge(001) substrates

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Abstract

Epitaxial mosaic-like Mn_5Ge_3 thin films were grown on Ge(001) substrates using reactive deposition epitaxy process from Mn deposition or Mn-Ge co-deposition at a substrate temperature of 250 °C using magnetron sputtering. The cross-sectional transmission electronic microscopy analyses reveal an abrupt interface at the atomic scale; two equivalent epitaxial relationships are found between the substrate and the Mn_5Ge_3 crystallites: $\text{Ge}(001)[110]$ and $[1\bar{1}0] \parallel \text{Mn}_5\text{Ge}_3(1\bar{1}1)[\bar{1}\bar{1}0]$. The c_{hex} axis of Mn_5Ge_3 forms an angle of 45° with the substrate plane. Rietveld analysis from a synchrotron 2-dimensional diffraction pattern revealed that remanent deformations of about 1% exist in the film. M - H measurements of 50-nm thick films elaborated by co-deposition revealed a saturation magnetization, M_s , of 636 kAm^{-1} , whereas the films elaborated by Mn deposition saturate at different values depending on the orientation of the applied magnetic field: $M_s^\perp=545 \text{ kAm}^{-1}$ and $M_s^\parallel=774 \text{ kAm}^{-1}$. This M_s difference is attributed to shape anisotropy of crystallites and interface quality of the films.

Keywords: Mn_5Ge_3 ; Ge(001); epitaxy; sputtering; synchrotron; magnetic properties.

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