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Integration of Multifunctional Epitaxial (Magnetic) Shape Memory Films in Silicon Microtechnology

Magnetic shape memory alloys exhibit various multifunctional properties, which range from high stroke actuation and magnetocaloric refrigeration to thermomagnetic energy harvesting. Most of these applications benefit from miniaturization and a single crystalline state. Epitaxial film growth is so far only possible on some oxidic substrates, but they are expensive and incompatible with standard microsystem technologies. Here, we demonstrate epitaxial growth of Ni-Mn-based Heusler alloys with single crystal-like properties on silicon substrates by using a SrTiO₃ buffer. We show that this allows using standard microfabrication technologies to prepare partly freestanding patterns. Our approach is versatile, as we demonstrate its applicability for the NiTi shape memory alloy and discuss for spintronic and thermoelectric Heusler alloys. This paves the way for integrating additional multifunctional effects into state-of-the-art microelectronic and micromechanical technology, which is based on silicon.

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