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Cryogenic Memory Elements Using Rare-Earth Nitride Thin Films

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The rare-earth nitrides are a series of ferromagnetic semiconductors with suitable properties for cryogenic memory applications, including quantum and superconducting computing systems. When grown as thin films, the magnetic and transport properties of rare-earth nitrides can be tuned independently by varying the growth conditions and rare-earth nitride selection [1]. In particular, solid solutions of two rare-earth nitrides allow for fine adjustment of the coercive field and magnetization [2, 3]. Here we form circular and elliptical islands (with lateral dimensions on the scale of $5\ \mu\text{m}$) from GdN/LuN/(Gd,Sm)N thin films for cryogenic memory applications. Binary memory states are achieved using the relative ferromagnetic alignment of the GdN layer and (Gd,Sm)N layer [4,5]. At 5 K, the alignment of the GdN layer can be reversed using applied fields in the order of 100 Oe while the (Gd,Sm)N layer maintains its original alignment. The magnetic field produced by the tri-layer islands in the aligned and anti-aligned states are modelled and found to be distinguishable for a nearby Josephson Junction.

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