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Xe-PFIB microstructuring of Yttrium Iron Garnet films for quantum magnonic applications

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Recently, the growing interest in quantum magnonics triggered intensive investigation of magnetic materials in the quantum limit. One of the main challenges in this area is to achieve long magnon lifetimes at cryogenic temperatures. Among all currently known magnetic materials, single-crystal Yttrium Iron Garnet (YIG, $Y_3Fe_5O_{12}$) possesses the lowest damping due to low spin-orbit coupling. Thin YIG films are, however, grown on GGG ($Gd_3Ga_5O_{12}$) substrates, which induce high magnetic damping at low temperatures [1,2].

Here we report on using Xenon Plasma Focused Ion Beam (Xe-PFIB) technique to prepare high-quality microstructured YIG films detached from GGG substrates [3]. This technique allows production of relatively large (50 x 50 x 20 μm^3) structures in a reasonable time of a few hours. The magnetic properties of these samples were evaluated using broadband ferromagnetic resonance spectroscopy in a wide temperature range (down to 80mK). Also, we developed a theoretical framework, which allows for fitting and predicting parameters of coupling in various macroscopic and microscopic hybrid structures.

We believe that our findings will pave the way to efficient implementation of YIG elements into hybrid quantum circuits.

Reference list

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