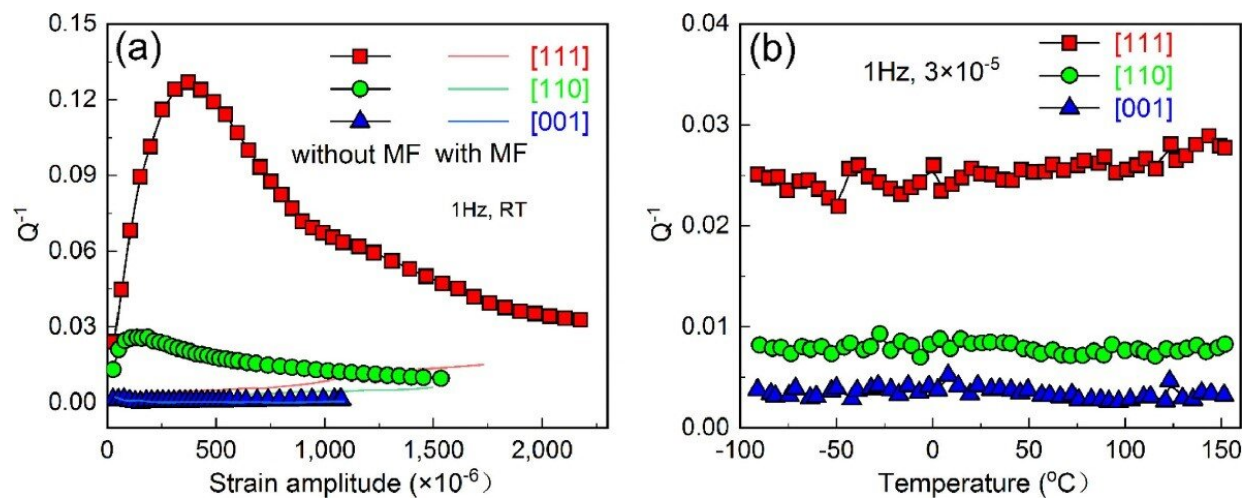


Ultra-high magneto-mechanical damping in Fe-Ga single crystals

February 23 2022, by Zhang Nannan



The variation of damping capacity with strain amplitude (a) and temperature (b) for [001]-, [110]-, and [111]-oriented single crystals at 1Hz. Credit: Sun Meng

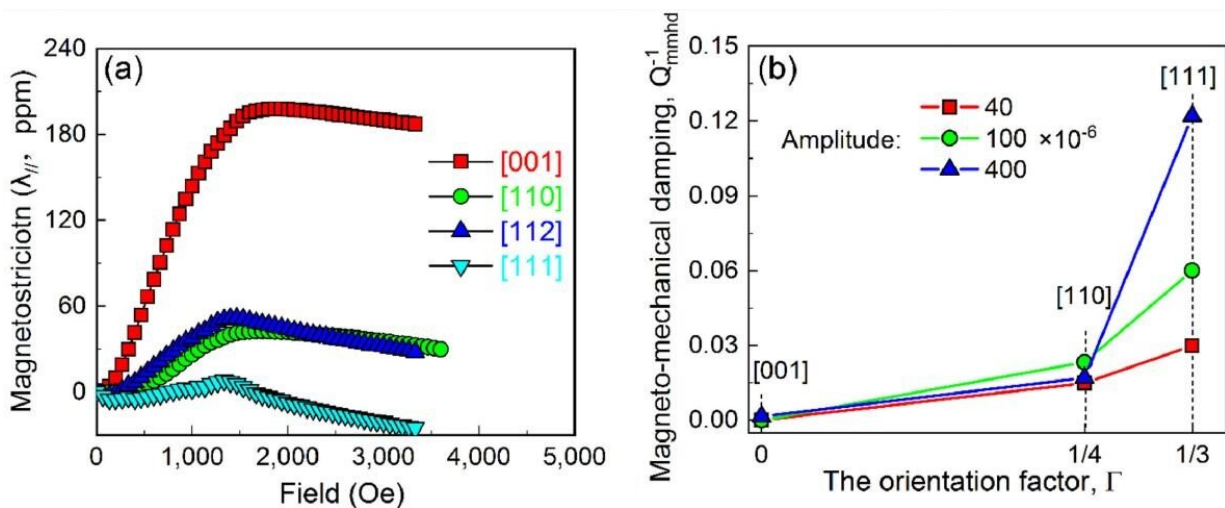
Fe-18 at.%Ga alloys with magnetostrictive coefficients up to 400 ppm are expected to have high damping based on the magneto-mechanical hysteresis damping (MMHD) model. However, in some studies of the magnetostrictive properties of Fe-Ga alloys, it was found that the magnetization curves of iron-gallium (Fe-Ga) alloys seem to be reversible, linear, and non-hysteretic curves, indicating that the damping is zero for Fe-Ga alloys. This contradiction makes it a challenge to explore the damping mechanism of Fe-based high damping alloys and possible ways to increase the damping of the alloys.

According to a recent study published in *Scripta Materialia*, researchers from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences have revealed ultra-high anisotropic damping in large-sized Fe-Ga [single crystals](#). "The MMHD value," said Sun Meng, first author of the study, "was two to five times higher than the damping value of existing conventional ferromagnetic metals."

In this study, the researchers found that the MMHD value of [111]/(110)-oriented FeGa single crystals reached an ultra-high 0.13 (SDC~0.82) under torsional deformation conditions, showing a strong orientation dependence.

In combination with the equivalent stress and magnetic field on the domain walls (DWs) and the in-situ observation of DWs motion under an applied [magnetic field](#), they confirmed that the high damping of Fe-Ga single crystals originated from the irreversible motion of the 90° DWs under alternating stress.

In the direction [100], MMHD was analyzed as a function of the direction factor and saturation magnetostrictive coefficient.



(a). Magnetostrictive curves of [001]-, [110]-, [111]-, and [112]-oriented single crystal samples; (b). Plot of MMHD versus the orientation factor. Credit: SUN Meng

The ultra-high damping effect in Fe-Ga [alloys](#) was achieved for the first time in this study. Most importantly, the large size Fe-GA single crystal preparation technology obtained has important engineering application prospect in microelectronic magnetostrictive devices and vibration reduction of aerospace precision instruments.

More information: Meng Sun et al, Ultra-high anisotropic magneto-mechanical damping in Fe-18at.%Ga single crystals, *Scripta Materialia* (2022). [DOI: 10.1016/j.scriptamat.2022.114552](https://doi.org/10.1016/j.scriptamat.2022.114552)

Provided by Chinese Academy of Sciences

Citation: Ultra-high magneto-mechanical damping in Fe-Ga single crystals (2022, February 23) retrieved 30 June 2024 from <https://phys.org/news/2022-02-ultra-high-magneto-mechanical-damping-fe-ga-crystals.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.