Coherent acoustic excitations in magnetic shape memory alloys

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Abstract
Excitation with femtosecond laser pulses allow to investigate the elastic properties of new material in the time domain [1]. Here we report on the time-domain investigation of magnetic shape memory alloys [2]. Ferromagnetic Ni-Mn-Ga alloys undergo a martensitic phase transition with little hysteresis, which enables the material to exhibit the shape memory effect. The large interest in applications arising from the large magnetic-field-induced strain in the material has led to intensive research about the microscopic origins of its structural phase transition. The martensitic lattice modulation has recently been described as an adaptive phase, constructed by micro-twinning of tetragonal martensitic unit cells. In contrast, a harmonic modulation and a charge density wave (CDW) ground state were proposed, supported by the observation of phonon anomalies in the austenite phase, the opening of a pseudogap and collective excitations. Here we present ultrafast pump-probe measurements, which are sensitive to both zone-folded acoustic modes in a superstructure and collective excitations in strongly correlated systems. We observe a mode at THz frequency in the martensite phase, which is strongly influenced by temperature and by the doping with cobalt, implying a strong electron-phonon coupling.

The following co-workers contributed to this work: Martin Schubert, Hanjo Schäfer, Jan Mayer, Mike Hettich, Aleksej Laptev, Moritz Merklein, Chuan He, Martin Grossmann, Oliver Ristow, Jure Demsar, Mikhail Fonin, Yuansu Luo, Konrad Samwer, and Vitalyi Gusev.

References

[1] Special issue Ultrafast Acoustics. Edited by E. Péronne and B. Perrin, Ultrasonics **56**, 1-171 (2015).
[2] M. Schubert et al., submitted.

Figures

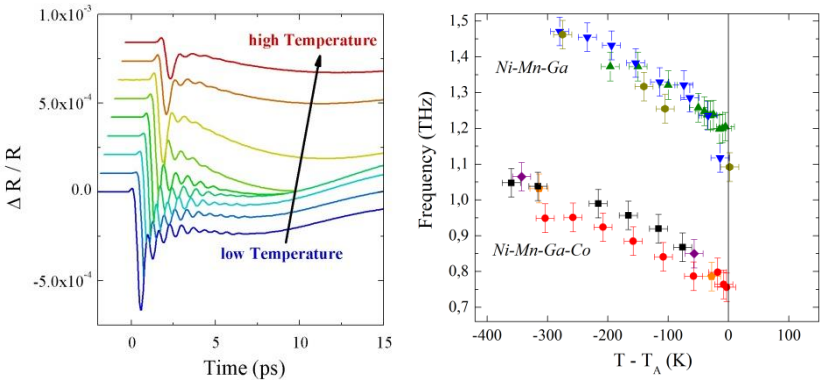

Figure 1: left: Time domain pump probe traces of NiMnGa shape memory alloy. Right: Extracted oscillations frequencies of NiMnGa and Co-doped NiMnGa for temperatures below the martensite-austenite phase transition temperature.