# Magnetic-resonance-induced modification of mechanical properties of crystals

V.I. Alshits,[1] M.V. Koldaeva,[1] E.A. Petrzhik,[1] E.V. Darinskaya,[1] R.M. Eremina,[2] A.V. Shestakov,[2] R.K. Kotowski,[3] and B. Gambin[4]

[1] *Shubnikov Institute of Crystallography of RAS, Moscow Russia*
[2] *Zavoisky Physical-Technical Institute of RAS, Kazan, Russia*
[3] *Polish-Japanese Academy of Information Technology, Warsaw, Poland*
[4] *Institute of Fundamental Technological Research PAS, Warsaw, Poland*

Magnetoplastic effect (MPE) is known as changes of nonmagnetic crystal's mechanical properties due to magnetic impact, [1]. Recently its manifestations were found even under ultralow fields in the EPR scheme when the sample was exposed to the crossed fields, static (the Earth field $\sim 50\ \mu$T) and alternating field (1-3 $\mu$T) of some resonance frequencies ~1 MHz, [1]. Here, we studied changes of dislocation mobility and the modification of microhardness in the NaCl crystal with the Ni impurity (~2 ppm). In our case, a series of rather narrow peaks of dislocation paths related to definite resonance frequencies were observed in the EPR scheme. In parallel, after exposure, a similar resonance decrease in the crystal microhardness was observed. The spectrum consisted of the two groups of softening peaks, nine ones in each group. These times we dealt with a memory effect, in which maximums of peaks were reached not immediately, but in 2-3 hours after the exposure. The necessary diffusion self-organization stage of the crystal with resonance transformed impurity centers to the new long-lived equilibrium metastable state needed a time. Then after the back transitions of those centers, the back diffusion processes provided weakening of the effect, the hardness slowly increased arriving at the initial level in a day. To check the magneto-activity of so small density of Ni impurities (~2 ppm), the same samples were used for an ordinary EPR analysis in the standard X-range ($\nu = 9.4$ GHz) at 4.2 K for different orientations of a sample with the magnetic field vector. All obtained spectra correlated with each other, indicating the same elementary acts in all cases, the spin-dependent electron transitions during the magnetic exposure of samples. The studied resonance spectra of mechanical characteristics were related to specifics of MPE at ultra-low magnetic fields in the EPR scheme. The transformed Ni centers were under the action of not only external static magnetic field but also of local crystalline magnetic field (e.g. from $Cl^-$ nuclei). In our case, the latter was ~100 times higher than the external Earth field. The interaction of impurity electrons with those ligands created the splitting of states of "zero field" and the related series of resonance transitions providing the experimentally observed spectra.

**References:**

[1] V. I. Alshits et al., **Phys.-Usp.**,Dislocation kinetics in nonmagnetic crystals: a look through a magnetic window (2017).