ESRF	**Experiment title:** Diffraction topographic investigation of the magnetoacoustic coupling in Iron Borate, $FeBO_3$	**Experiment number:** HE 69
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Report:

The investigation of magnetoacoustic phenomena in magnetic materials is relatively new. So far, there has been some theoretical work mainly by Russian teams resulting in models and theories that try to explain the coupling between the magnetic and the elastic subsystems of such crystals' The experimental work that followed, was also done by Russians and mainly using neutron topography2. Evidently, using synchrotron radiation instead of neutrons increases significantly the resolution and the sensitivity of the diffraction and topographic methods when studying these magnetoacoustic excitations.

X-ray diffraction topography is a technique very sensitive to lattice distortions, The fact that thin crystals of $FeBO_3$ are of high crystalline quality allows the observation of dynamical effects such as resonance effects associated with the excitation of the natural vibrations of the crystal. The real time observation of the crystal quality degradation caused by a resonant excitation was done with the help of a fast sofretec camera and the results were recorded on Kodak Industrex film.

An Iron Borate crystal of a thickness of about 70µms was used. Iron Borate has the calcite structure and grows in the form of thin hexagonal platelets parallel to the (11 I) plane. It is a weak antiferromagnet, i.e. it is characterized by a spontaneous ferromagnetic moment at room temperature and the plane of the plate is the plane of easy magnetization. Fig.1, simply shows what the FeB03 sample we used looks like. We clearly see a crack along the crystal and the different domains that tend to form close to regions of large inhomogeneity. When applying a steady magnetic field of a few Oersted along the plane we can remove the domain structure (Fig.2).

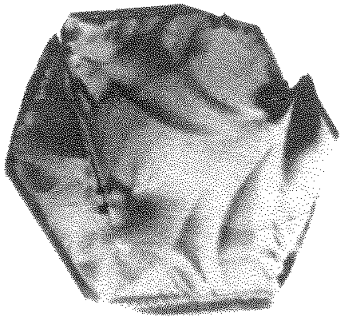

Fig1: Domains in crystal

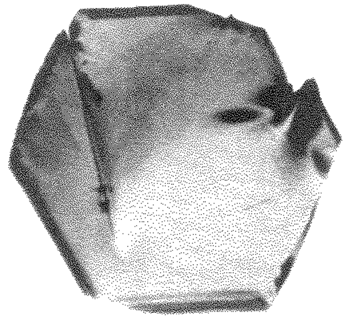

Fig2 Crystal under steady field

The further application of an alternating magnetic field at right angles to the steady field results to a strong coupling between the vibrating magnetic moments and the crystal lattice. Such a magnetostrictive interaction results in resonancies at certain frequencies producing this way standing elastic waves within the crystal

Figures 3,4 and 5 visualize the sort of resonant effects we could observe at the frequecies of 1.273MHz and 1.949MHz respectively. In the first case the standing wave has a preferred direction along the two parallel and opposite sides of the hexagon, whereas, the crack and the crystal edges serve as boundary conditions In such a case, one could draw several quantitative conclusions about the standing wave, such as the fact that the dark lines are the nodes being areas of high distortion. However, we very often had cases where the image looked like the one of fig.5 with beautiful but hard to interpret patterns.

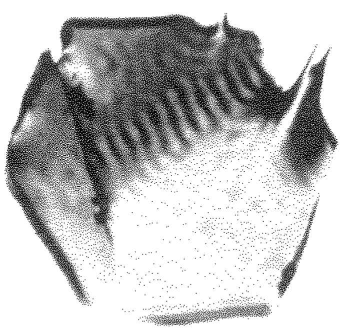

Fig3: 1.273MHz, 0.32A

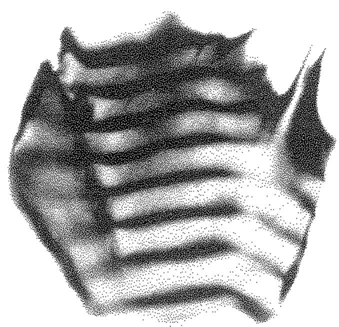

Fig4: 1.273MHz, I .38A

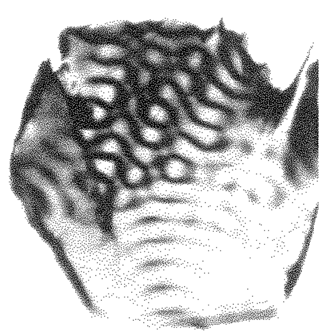

Fig5: 1.949MHz

It is clear, that a further study of this phenomenon is required. Some very first experiments one could do is try several reflections simultaneously for different resonancies, use monochromatic beam and investigate the role of the steady magnetic field on these resonancies which appears to be very influential (compare Fig3 and 4).

References

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