ABSTRACT CODE

Phonon dispersion in uranium measured using inelastic X-ray scattering

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The conventional method to measure phonon dispersion curves is with neutron inelastic scattering. However, relatively large crystals are required. For example, in the case of alpha-uranium these measurements[1] were performed 23 years ago on a crystal of 100 mm^3. Clearly, this requirement in terms of crystal size is a severe handicap for actinides. A new technique has been developed in the last decade at 3rd generation synchrotron sources, and that is inelastic x-ray scattering (IXS). (Actually the first measurements were done some 20 years ago, but it is only with the high brilliance of 3rd generation sources that the technique has become routine.)

In our first attempt on an actinide we decided to re-measure the phonons in α-U as a test experiment at the SRI-CAT of the Advanced Photon Source (APS) at Argonne National Laboratory. The spectrometer[2] was operated with an incident energy of 21.657 keV (λ = 0.57 Å). This energy was chosen to give the maximum flux with a resolution of ~ 2 meV (Ref. 2), but has the unfortunate consequence that it is just 700 eV *above* the L_2 edge of uranium at 20.95 keV. The calculated low penetration depth of ~ 6 μm and accompanying large fluorescence initially suggested the experiment would not succeed, or at least be very difficult.[3] Despite this, excellent data were obtained in a relatively short time.

Modes displacing atoms along [00ζ] and propagating in all three high symmetry directions were measured. Whereas the acoustic modes agree with the neutron measurements, the longitudinal optic branch is about 10% higher in energy, but consistent with higher cutoff energies observed in phonon density-of-states measurements on polycrystals[4]. The application of this X-ray technique, which requires only very small samples (the mass of the sample scattering the x-rays is calculated as 40 μg), opens new possibilities in actinide science. An account of this work has just appeared in Phys. Rev. B **67**, 052302 (2003).

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