Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Measuring phonon dispersion relations with momentum- and energy-resolved x-ray calorimetry. RUQING XU, U. of Illinois at Urbana-Champaign, HAWOONG HONG, Argonne National Lab, T.-C. CHIANG, UIUC — X-ray Thermal Diffuse Scattering (TDS) is a powerful method for determining phonon dispersion relations, as has been demonstrated in a number of experiments. However, most previous studies employed a fitting procedure based on presumed atomic force constant models, and the results could be susceptible to systematic errors. In view of this issue, we have developed a new method based on momentum-resolved x-ray calorimetry: the phonon frequencies at specific wavevectors are determined directly from the temperature dependence of the TDS intensities, with no force constant models needed. A test of this method on Cu has yielded excellent results. However, a limitation exists for this method, as it requires data taken over a wide temperature range, and the minimum temperature must be significantly lower than the Debye temperature. This can be a problem for materials with phonon frequencies that change significantly with temperature. To overcome this problem, we are experimenting with another method: the scattered x-rays are energy analyzed, and the TDS intensity is determined relative to the Compton scattering intensity. With this internal intensity calibration, phonon frequencies can now be determined from TDS data taken over a narrow temperature range. Results of a test study on chromium will be presented.

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Date submitted: 21 Nov 2008 Electronic form version 1.4