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A new X-radiography based method for measuring thermal diffusivity at high pressures

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We have developed a new variation of the Ångstrom method for measuring thermal diffusivity at high pressures by using X-radiography. We have measured the thermal diffusivity of a number of upper-mantle and transition-zone phases and our data are in agreement with previous measurements.

The Ångstrom method for measuring thermal diffusivity at high pressure uses a stationary thermal wave which is induced in the sample by varying the power sinusoidally in the surrounding cylindrical furnace. The thermal diffusivity (κ) is determined from the phase lag, $\Phi_0 - \Phi_R$, and amplitude difference, θ_0/θ_R, of the thermal wave between points at the axis of the sample and radius, R (e.g. Khedari *et al.*, 1995).

Our method differs from previous multi-anvil implementations of the Ångstrom method in that instead of using thermocouples to monitor the temperature variation we use thin strips of metal foil, which are placed at discrete intervals along the sample length and imaged X-radiographically. The metal strips monitor the thermal expansion of a slice across the sample in response to the sinusoidal temperature profile. This represents an improvement over previous methods since (i) the change in temperature is averaged along the sample length, (ii) we measure the phase of the thermal wave at all radii and (iii) since the expansion of the sample is observed as a proxy for the change in temperature there are no problems associated with contact thermal resistance at the thermocouples. Furthermore, this development does away with the need to prepare long cylinders of weakly metastable phases with a thermocouple inserted precisely down the middle; a process which is technically extremely difficult.

To date we have measured the thermal diffusivity of NaCl, olivine, majorite and a number of other upper-mantle and transition-zone phases. The measurements we have made are all in agreement with previously published data. The simplifications to the technique inherent in this X-radiographic technique will allow us to measure the thermal diffusivity of lower-mantle phases.