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X-ray diffraction at very high pressure

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The highest static pressures are generated today using diamond anvil cells (DAC). Diamonds are not only transparent for visible radiation but also for x-rays making it possible to study the structure of matter at very high pressures with x-ray diffraction. Sample volumes are small (typically 0.1 x 0.1 x .03 mm^3 for pressures to 60 GPa) requiring small beams (0.05 x 0.05 mm^2) with high photon fluxes. Two different methods are used to perform x-ray diffraction experiments at very high pressures. In the energy dispersive (EDX) method, the scattering angle 2θ is fixed, and diffraction patterns are measured as a function of photon energy with solid state detectors. In the angle dispersive (ADX) method, the photon energy is fixed, and diffraction pattern are collected as a function of the scattering angle 2θ, today mostly by using area detectors (image plates, CCDs). Both methods are successfully utilized at the ESRF. The equation of state of the hydrogens (H2 and D2) has been measured to 120 GPa using single crystal EDX. EDX is further very useful where data collection times are short (in laser heating and time-resolved experiments for example). ADX with image plates has been used to study structural changes with pressure in various materials. For example phase transitions at high pressures have been investigated in N_2 (to 50 GPa), O_2 (to 116 GPa) and Ge (to 80 GPa).