Experimental measures of the orientation dependence of the B1-B2 transformation in shock-compressed MgO

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Of the over 6,000 confirmed and candidate extrasolar planets discovered to date, those 1-4 times the radius of the Earth are found to be most abundant. MgO (periclase), is expected to be a major component of the deep mantles of terrestrial planets and exoplanets. Its high-pressure transformation from a rocksalt (B1) structure to the B2 (CsCl) structure is expected to occur in rocky exoplanets greater than about 5 Earth masses in size. In this work, the structure and temperature of MgO upon shock compression over the 200-700 GPa pressure range was examined at the Omega-EP Laser facility. Laser drives of up to 2 kJ over 10 ns were used to shock compress single-crystal MgO. At peak compression, the sample was probed with He-α X-rays from a laser-plasma source. Diffracted X-rays were recorded on image plates lining the inner walls of a box attached to the target package. For each shot we measure pressure (velocity interferometry), density (x-ray diffraction) and shock temperature (pyrometry). We also probe orientation-dependence of the shock Hugoniot by conducting laser-driven decaying shock measurements of single crystal MgO [100], [111] and [110], and will discuss the importance of single crystal experiments to better improve phase diagram models of materials at extreme conditions.

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