Compression rate dependence of the α to ω phase transition in titanium

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Titanium (Ti) is commonly used in industrial applications such as aerospace, automotive and biomedical due to its corrosion resistance and high strength to density ratio. At high pressure(2.9-10.5 GPa), Ti transforms from the hexagonal close packed α phase to the open hexagonal ω phase.[1] The ω phase of Ti is brittle and recoverable at ambient pressure and therefore alters the properties of Ti. It is therefore important to understand this phase transformation of Ti as it is known to be affected by several factors including (i) the pressure medium used, (ii) the presence of impurities, and (iii) the compression rate.[1, 2] So far, Ti has mostly been compressed using 'slow' quasi-static or 'fast' shock compression; only one intermediate compression rate has so far been reported.[3, 4] In 2007, Evans et al. described a method for using a piezoelectric crystal to drive a diamond anvil cell, this is known as a dynamic diamond anvil cell (dDAC).[5] This method allows for controllable compression rates, ramp profiles and pressures. In the decade since, developments in both synchrotron technology (including fast detectors) and dDACs have made it possible to use time resolved X-ray diffraction to investigate phase transformations at significantly higher compression rates than conventional DACs, up to 102 TPa/s.[6, 7] These new developments have been used to further understand the phase transformation of Ti under hydrostatic and non-hydrostatic conditions at critical compression rates between static and shock compression rates. Recent dDAC experiments compressing Ti at compression rates between 2.5 and 3500 GPa/s indicate that at faster compression rates, under non-hydrostatic compression (without a pressure medium), the starting and completion pressure of the α to ω phase transformation in Ti increases.

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