Experimental exploration of TiN as a a possible reservoir for planetary nitrogen

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Estimates of the Bulk Silicate Earth (BSE) nitrogen (N) budget do not match predictions from chondritic estimates. Namely, the C/N ratio of the BSE is high (~40 [1]) as compared to the average chondritic ratio (~21 [2]), implying a low BSE N content. Several hypotheses have been suggested to explain this discrepancy, such as the loss of an early N_2-rich atmosphere [1] or the incorporation of differentiated starting materials later in Earth's accretion [2]. If N is instead more compatible in the mantle than other volatiles such as carbon (C), it may be possible that N is sequestered in stable mantle phases. One possible stable N-containing phase is Osbornite (TiN) [3]. TiN is found naturally in enstatite chondrites [4], and has been observed to form experimentally in MORB samples saturated in N at low fO_2 conditions [5]. Here, we explore the stability of TiN at high pressure and high temperature in a diamond anvil cell, to test whether or not TiN could act as a stable N-bearing compound under planetary mantle conditions. Using synchrotron x-ray diffraction, we measured the thermal equation of state of Osbornite up to pressures of ~70 GPa while heating to 2500 K. We find a preliminary equation of state (K = 286 (±6) GPA and K' = 4.5 (±0.2)) that agrees well with previous measurements to 45 GPa at room temperature [6]. We find that the cubic rocksalt phase of TiN remains stable at all conditions considered, meriting further study as a possible N reservoir within planetary mantles.

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