

## **An electrical conductive and ferromagnetic submicron-structure manganese mono-boride with high Vickers hardness**

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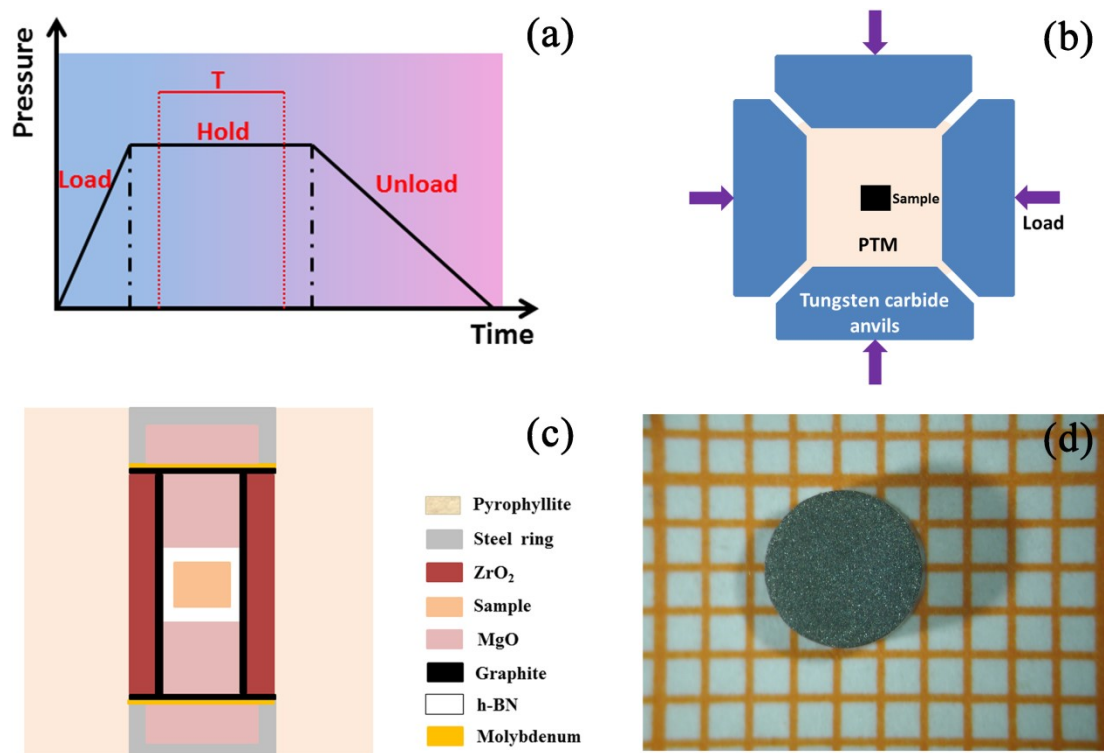
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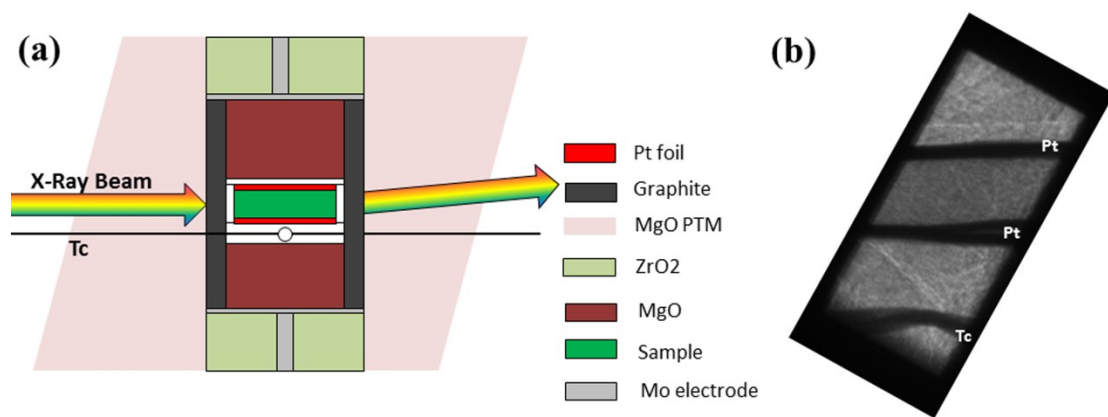
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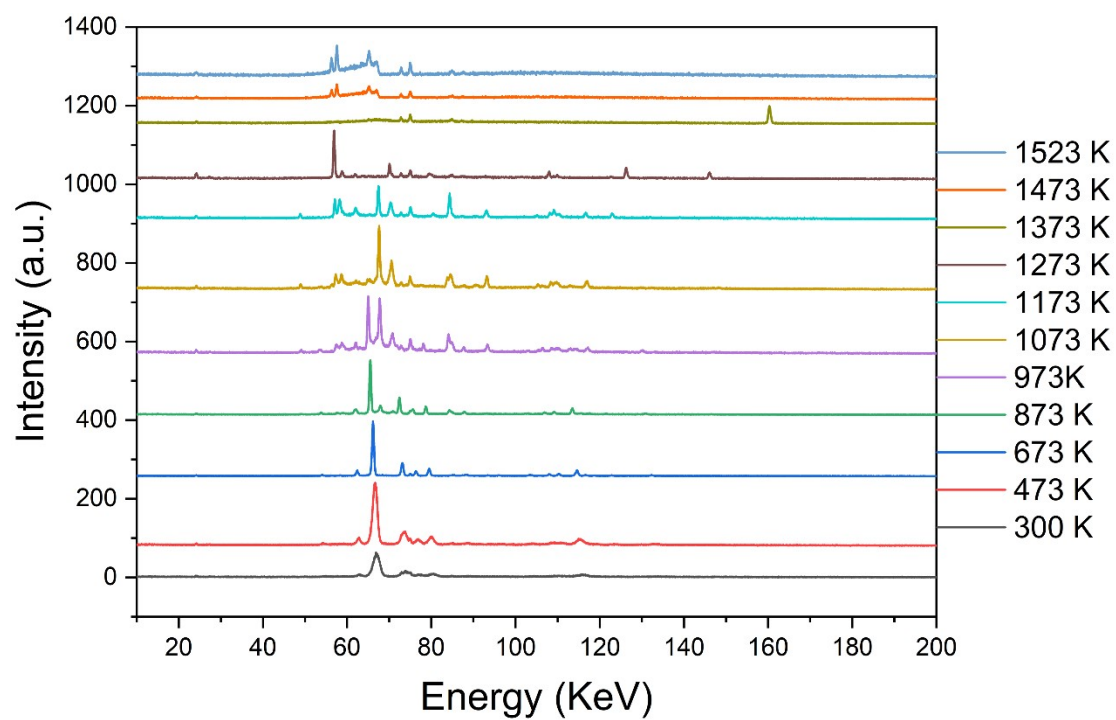
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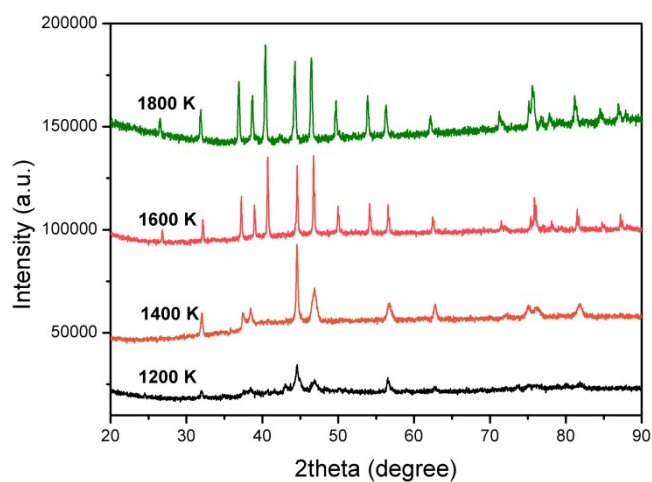
**Figure S1.** (a) The high pressure and high temperature (HPHT) experiment profile of typical HPHT experiment. (b) The cavity structure diagram of cubic high pressure experiment. (c) The sketch of cubic high pressure assembly for our HPHT experiments. (d) The optical images of the synthesized sample.



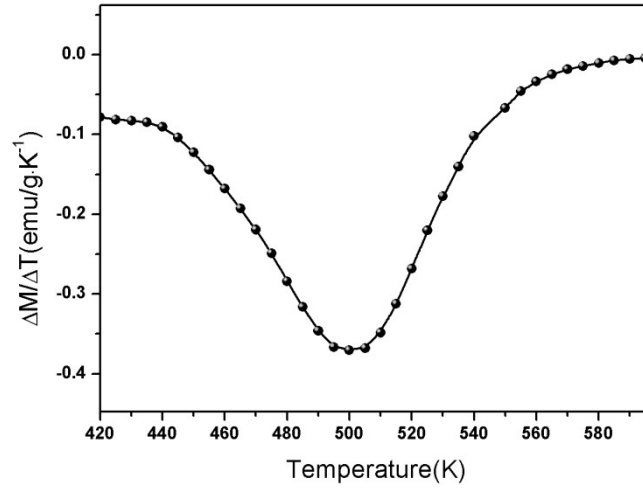
**Figure S2.** (a) The sketch of the high pressure assembly for high pressure and high temperature synchrotron experiment. (b) The tomography images of the assembly under about 5.0 GPa.



**Figure S3.** The in-situ energy dispersive X-ray diffraction spectra (EDXRD) of Mn:B=1:1 under 5 GPa with different temperature.



**Figure S4.** The x-ray diffractions of the recovered sample that synthesized at different temperature and pressure of 5 GPa.



**Figure S5.** The derivative of magnetic susceptibility around the transition temperature of  $\alpha$ -MnB.

**Table 1.** The synthesis conditions, phase composition and the measured properties.

Run Number	Conditions	Phase	Hardness	Magnetic	Measurement
SKL-C-885	5.0 GPa, 1200 K, 20min	$\alpha$ -MnB			
SKL-C-886	5.0 GPa, 1400 K, 20min	$\alpha$ -MnB	16.7 GPa	FM	TG-DTA XPS SEM
SKL-C-887	5.0 GPa, 1600 K, 20min	$\beta$ -MnB	15.7 GPa	FM	
SKL-C-888	5.0 GPa, 1800 K, 20min	$\beta$ -MnB			
HH372BL	5.0 GPa, 300 K-1523K With beam	$\alpha$ -MnB			
HH319	3.0 GPa, 1273 K, 20min	$\alpha$ -MnB			XAS
HH322	3.0 GPa, 1173 K, 20min	$\alpha$ -MnB+Mn			
HH323	3.0 GPa, 1073 K, 20min	$\alpha$ -MnB+Mn			