Title:**Microstructures reveal molten history**

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**Abstract:** High-pressure melting anchors the phase diagram of a material, revealing the effect of pressure on the breakdown of the ordering of atoms in the solid. An important case is molybdenum, which has long been speculated to undergo an exceptionally steep increase in melting temperature when compressed. On the other hand, previous experiments showed nearly constant melting temperature as a function of pressure, in large discrepancy with theoretical expectations. Here we report a high-slope melting curve in molybdenum by synchrotron X-ray diffraction analysis of crystalline microstructures, generated by heating and subsequently rapidly quenching samples in a laser-heated diamond anvil cell. Distinct microstructural changes, observed at pressures up to 130 gigapascals, appear exclusively after melting, thus offering a reliable melting criterion. In addition, our study reveals a previously unsuspected transition in molybdenum at high pressure and high temperature, which yields highly textured body-centred cubic nanograins above a transition temperature.