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# Amorphous–amorphous transition in $SnI_4$ reexamined

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The pressure-induced solid-state amorphization found in 1985 [1] set off a series of subsequent researches on polyamorphism in $SnI_4$. The discovery of another amorphous state [2], called Am-II to Am-I previously identified, on decompression became a breakthrough in solving the puzzle.
Later, a consistent thermodynamic argument has been given for the observed polyamorphic behaviors [3]. However, the following questions remain unanswered: The ambient crystalline phase CP-I never transforms into Am-II, which appears only on Am-I decompression. Nonetheless, CP-I can directly transform to Am-I on *recompression* skipping CP-II [4], the high-pressure modification of CP-I.
We reexamined the Am-I-to-Am-II process conducting high-pressure synchrotron x-ray diffraction studies with a diamond anvil cell [5]. Detailed analysis of the structural evolution revealed that the association of molecules, which are entirely dissociated, starts at around 14 GPa on decompression. About 30% of isolated Sn atoms suddenly complete the molecular formation at the Am-I-to-Am-II transition at 3.3 GPa, associated with an abrupt drop of density. Thus, the molecules formed recover their original symmetry of $T_d$ at the transition, implying the strong coupling between the global order parameter of density and the local symmetry.
Because the centers (Sn atoms) were distributed everywhere in Am-I, formed molecules' resulting location is not necessarily energetically optimized, leaving uniform distribution of shorter (2.64 Å) van der Waals $I_2$ bonds, which play as *defects*. The open questions are then understandable in terms of the defects. Crystallization of Am-II to CP-I could be a defect extinction process, but the reverse process would hardly occur. It seems impossible to remove the whole defects in recovering CP-I, and the residual defects prevent defective CP-I from reordering to CP-II, which may require highly ordered stacking of Sn layers [6].
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