Generation of ~90 GPa in Kawai-type multianvil apparatus using nano-polycrystalline diamond anvils.

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Nano-polycrystalline diamond (NPD) has higher hardness, toughness, elastic stiffness, and X-ray and light transmittance than conventional sintered diamond (SD). These properties make it suitable for use as an anvil material in high-pressure experiments. Kawai-type multi-anvil apparatus (KMA) has been widely used in high-pressure experiments, where accurately controlled pressure and temperature in larger sample volumes relative to diamond anvil cell are available using tungsten carbide (WC) or SD as the second-stage anvil materials. However, the generated pressures in KMA with these conventional anvils at high temperatures have been limited to about 40 GPa and 100 GPa, respectively, by using these materials as the anvils. We have been attempting to generate further higher pressures using NPD cubes with the “6-6-8” anvil configurations. *In situ* X-ray diffraction measurements and radiographic imaging observations were performed at the large-volume press beamline, BL04B1, SPring-8. Baked pyrophyllite gasket and semi-sintered Al_2O_3 pressure medium were used, and a folded gold foil was placed in the center of the pressure medium as a pressure marker. The maximum pressure so far achieved at room temperature is about 88 GPa at a press load of 3.4 MN, which is far higher than that achieved using SD anvils (~56 GPa) with the identical cell assembly and the press load. Moreover, it was found that both in situ X-ray diffraction measurements and imaging observations are possible even through the NPD anvils, which is great advantage over the experiments using SD anvils where the invisibility of the sample becomes a serious issue due to the plastic deformation of anvils under such high pressure. Thus, we conclude NPD is highly promising anvil material for the next generation KMA technology.

