New tungsten carbide anvils potentially important for melting experiments under lower mantle conditions

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Kawai-type multianvil apparatus (KMA) is important for accurate determinations of melting relations and element partitioning to understand the processes relevant to the interaction and co-evolution of the Earth’s mantle and core. Recent developments in KMA technology with sintered diamond (SD) anvils has enabled to expand the pressure range available in this apparatus toward Mbar regime. However, the use of SD anvils has been limited only to very few laboratories due to both technological and financial reasons, as SD anvils are much expensive compared to tungsten carbide (WC) anvils and also specially designed large-volume apparatus is required to successfully pressurize the cell assemblage using SD anvils. Recently, a new class of “binderless” WC (Fujilloy TJS01) has been developed by Fuji Di. Co. Ltd., which is claimed to be harder than any other commercially available WC. We have tested this novel WC as second-stage anvils for KMA based on in situ X-ray observations at SPring-8, and found that the anvils made of this WC indeed yield pressures significantly higher than those available with other WC anvils frequently used in the KMA community. Pressures up to about 50 GPa were confirmed at room temperature with an anvil truncation (TEL) of 1.5 mm, which is about 20% higher than that achievable using the hardest known WC (Fujilloy TF05) anvils. Thus, this novel WC is potentially important for melting experiments of silicate-metal systems under simultaneous high pressure and high temperature conditions of the deep interior the early Earth (e.g. 30-50 GPa, ~3500K), which are currently difficult to be reached in KMA with either conventional WC or SD anvils

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