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High Pressure Compressive Shear of Non-Fully Dense Materials

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High Pressure Compressive Shear (HPCS) [1] has been shown to impart ultrafine grain microstructures in fully-dense metals and alloys. In this work, the HPCS technique has been extended to non-fully dense materials, including green compacts of iron-based composite nanoparticles and monolithic micron-sized copper powders. Our primary hypothesis is that the material rotations due to shear can increase the rate and maximum degree of densification. Theories of the deformation of variable-density materials guided selection of ratios of shear and compression.

HPCS was applied using constant shear/compression strain ratios between 0 and 10 and using more complex non-proportional strain histories. The addition of shear straining to compressive straining was found to enhance densification beyond the levels achievable by uniaxial compression only. The optimum magnitude of shear displacements added to compression were found to depend on characteristics of the particles.

Keywords: Densification, particle compaction, high shear deformation, non-proportional loading

Fig.1 High Pressure Compressive Shear tooling

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References:

[1] L.S. Toth, et al., The mechanics of High Pressure Compressive Shearing with application to ARMCO® steel, Matls Characterization, 154 (2019) 127-137