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Deformation Behaviour of Coarse Grain Alumina under Shock Loading

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To develop better understanding of the shock wave induced deformation behavior of coarse grain alumina ceramics, and for measurement of its Hugoniot Elastic Limit (HEL), in-situ and recovery gas gun experiments have been carried out on coarse grain alumina (grain size $\sim$ 10 μm), prepared in the form of discs (>99.9% TMD) by pressure-less sintering of alpha alumina powder at 1583 K. The HEL value of 1.9 GPa has been determined from the kink in the pressure history recorded using piezoresistance gauge and also from the free surface velocity history of the sample shocked to 9 GPa. The nano-indentation measurements on the alumina samples shocked to 6.5 GPa showed hardness value 15% lower than 21.3 GPa for unshocked alumina, and strong Indentation Size Effect (ISE); the hardness value was still lower and the ISE was stronger for the sample shocked to 12 GPa. The XRD measurements showed reduced particle size and increased microstrains in the shocked alumina fragments. SEM, FESEM and TEM measurements on shock treated samples showed presence of grain localized micro- and nano-scale deformations, micro-cleavages, grain-boundary microcracks, extensive shear induced deformations, and localized micro-fractures, etc. These observations led to the development of a qualitative model for the damage initiation and its subsequent growth mechanisms in shocked alumina. The work performed in collaboration with K.D. Joshi of BARC and A.K. Mukhopadhyay of CGCRI.