(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :12/01/2023

(21) Application No.202341002613 A
(43) Publication Date : 17/02/2023

(54) Title of the invention : HIGH DENSITY INDEX COMPOSITE MATERIAL AND PROCESS FOR PREPARING THE SAME

(51) International classification :C06B0043000000, C22C0032000000, C04B0035580000, B01J0023000000, C22C0001040000
(86) International Application No :PCT//
Filing Date :01/01/1900
(87) International Publication No : NA
(61) Patent of Addition to Application Number :NA
Filing Date :NA
(62) Divisional to Application Number :NA
Filing Date :NA

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(57) Abstract :
Materials capable of armor penetration and prompt chemical energy release are desired for future weapon systems in order to better couple the kinetic energy of a projectile to its target. High-density metals used today such as tungsten are slow to react, and do not generate as much chemical energy as lower density materials, such as aluminum or boron. To design materials with a high density and reactivity, composites including boron, titanium and tungsten were prepared by mechanical milling. The specific composition density was chosen to match that of steel, 7.8 g/cm3. The proportions of the elemental metals were selected to induce a highly exothermic formation of titanium boride, which would raise the material temperature and assist the initiation and combustion of tungsten. Composite powders were prepared using both single-step and staged milling protocols, and characterized by electron microscopy, x-ray diffraction, thermal analysis, and a custom constant-volume combustion test. Staged milling produced powders with the best degree of refinement while preventing intermetallic reactions during milling. An optimized structure with well-refined components capable of a rapid combustion was prepared by milling elemental B and W for 4 hours, followed by the addition of Ti and milling for an additional 2 hours in a second stage. The combustion test showed evidence of tungsten combustion upon initiation of all prepared ternary materials in an oxidizing environment. The tungsten combustion occurred most effectively, generating the highest pressure and rate of pressure rise for the material with the optimal microstructure.

No. of Pages : 4 No. of Claims : 7