Use of wave refractions and reflections to reduce transmitted shock and fragment bullets in metallic foam ceramic architected material

Stefan Szyniszewski*[1], Rene Vogel[2], Ludovic Blanc[3], Tomasz Jankowiak[4], Teresa Fras[3], Florian Bittner[5], Hans-Josef Endres[5], Thomas Hipke[2], and Ewa Jakubczyk[1]

[1]University of Surrey – University of Surrey, Guildford Surrey GU2 7XH, United Kingdom
[2]Fraunhofer IWU – Reichenhainer Strasse 88, 09126 Chemnitz, Germany
[3]Institut franco-allemand de recherches de Saint-Louis – French-German research institute of Saint-Louis (ISL), Saint-Louis, France – 5 rue du Général Cassagnou, BP 70034, 68300 SAINT-LOUIS - France, France
[4]Poznan University of Technology – Piotrowo 5, 60-965 Poznan, Poland
[5]WKI Fraunhofer – Heisterbergallee 10A (ehemals 12), 30453 Hannover, Germany

Abstract

Wave dynamics and high-frequency vibrational mechanisms were employed to create new metallic foam ceramic material, called by our team, Proteus. Architected materials, such as 3D lattices or spatially organized architectures made of multiple base materials can block transmission of acoustic waves (phononic band gap materials) or attenuate blast waves. Our team created a metallic foam structure with a spatial grid of high oxygen content ceramic spheres. We tested blast wave attenuation and resistance to armor-piercing bullets experimentally at ISL in France. Our experimental work was supplemented with computational studies of the wave propagation toward modeling of ballistic impacts shortly. Our material is also non-cuttable due to the vibrational mechanism at the interface with cutting tools such as an angle grinder or power drill. We believe that Proteus has the potential to achieve lighter protective structures with a broad range of protective capabilities.

Keywords: architected material, wave refractions, reflections, metallic foam, ceramic composite, blast, ballistic

*Speaker