Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Fracture behavior of brittle microspheres using indentation and compressive loading techniques

Zbib, Mohamad, zee_mz@hotmail.com; Parab, Niranjan; Chen, Wayne; Bahr, David, Purdue University, United States

ABSTRACT

The fracture behavior of small spheres of silica, glass, silicon, and yttria-stabilized zirconia (YSZ) has been studied with different loading techniques. Spherical particles come under impact loading both during materials processing, transportation and construction, and high strain rate loading of ballistics; the resulting integrity of the spherical particles plays a role in both the subsequent processing and the energy absorption capabilities of the material. Nanoindentation has been used to measure the hardness (*H*) and elastic modulus (*E*), and microindentation has been used to measure the fracture toughness (*T*) of the materials. High speed X-ray phase contrast imaging was used to examine the failure mechanism under dynamic compression for individual particles with diameters (*d*) that range between 500 and 2000 µm. Static testing of particulates using bulk indentation of granular solids also can lead to sample failure. A pulverization model has been developed to better understand the failure of the materials. The pulverization parameter is presented by $P = Hd^{0.5}/T^2$. The preliminary results show that materials that exhibit pulverized failure under high strain rate compressive loading, such as silica and glass, have high *P* values. YSZ shows a single crack under compressive loading and has the smallest *P* value, whereas silicon exhibits substantial but still distinct cracking and has a medium *P* value. The effects of strain rates are also discussed in this presentation.