A Laser shocked induced densification of silica glass studied by both experience and molecular dynamic simulation.

Corentin Dereure*†[1], Richard Renou[2], Didier Loison[1], Emilien Lescoute[2], Mariette Nivard[1], Alain Moréac[1], Jean-Christophe Sangleboeuf[1], Laurent Berthe[3], Laurent Soulard[2], and Jean-Pierre Guin[1]

[1]Institut de Physique de Rennes (IPR) – Universite de Rennes 1, Centre National de la Recherche Scientifique : UMR6251 – Bâtiment 11A , B, C, E – 10B263 av. Général Leclerc35042 Rennes cedex FRANCE, France

[2]Division Ile de France (DIF) – CEA-DAM, CEA-DAM – Bruyères-le Châtel, 91297 Arpajon, France

[3]Procedes et Ingenierie en Mécanique et Matériaux [Paris] (PIMM) – Arts et Métiers ParisTech, Conservatoire National des Arts et Métiers (CNAM), CNRS : UMR8006, Conservatoire National des Arts et Métiers [CNAM] – 151 boulevard de l'hôpital, 75013 Paris, France

Abstract

Understanding and modeling the mechanical behaviour of silicate glasses under both high pressure (up to several GPa) and high strain rate (up to 10ˆ9 s-1) loading conditions encountered during hyperveloce impacts is of interest for applications such as high power laser facility (National Ignition Facility in USA or Laser MegaJoule in France) or aerospace fields (solar panel and window). Pure silica, borosilicate or soda lime glasses have been studied for strain rate about 10ˆ5 s-1 using plate impact or explosive device to obtain Hugoniot curve and observe failure wave mechanism. To study these materials under hyperveloce impact conditions, laser shock experiments instrumented by VISAR and transverse shadowgraphy were performed using high-power laser facilities. Pressures in the range of tens of GPa were generated with very limited to no surface damage for pure silica glass. Laser shock experiments allow for the recovering of the impacted sample for post-mortem investigations such as 3D confocal Raman spectroscopy to study for instance residual structural modifications. Raman spectroscopy results are presented for different loading conditions and discussed in the light of the literature (quasi-static loading and thermal history). Furthermore the time scale compatibility of both laser shock tests and Molecular Dynamic simulations offers a real opportunity for a comparison and discussion of the results in terms of residual densification ratio and structural modifications.

Keywords: Silica glass, laser shock, Densification, Raman spectroscopy, Molecular Dynamics

*Speaker

†Corresponding author: corentin.dereure@univ-rennes1.fr