Laser-induced melting experiments: Simulation of impact processes

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Impact processes and associated melting including mixing of projectile and target material cannot be studied with conventional experimental tools, but through hypervelocity impact experiments, which are expensive and time consuming. This study introduces an experimental approach using a high-energy laser beam simulating the virtually instantaneous melting associated with meteorite impact.

Laser-induced melting experiments (LE) were conducted with the Trumpf Haas HL 3006D laser welding facility at the Technical University of Berlin, aiming at the production and investigation of target (sandstone) and projectile (iron meteorite and steel) melts and their mixtures. The LE were able to produce features very similar to those of impactites from meteorite craters and cratering experiments [1-4], this includes formation of lechatelierite, partially to completely molten sandstone, and injection of projectile droplets into target melts. Target and projectile melts experienced significant modification during chemical interaction of these coexisting melts. Emulsion textures, observed within projectile-contaminated target melts, indicate phase separations of silicate melts with different chemical compositions during quenching. This liquid immiscibility phenomenon was recently described for the impact glasses of the Wabar craters [2] [3] and Meteor crater [3]. The laser technique does not reproduce typical high-pressure shock effects, e.g. planar deformation features in quartz, but it can be definitely used to simulate high-temperature effects of an impact, mainly for the investigation of geochemical processes.

LE allow (i) high-temperature melting to better constrain primary melt heterogeneities before mixing, and (ii) the quantification of element partitioning processes between coexisting projectile and target melts. Processes of minor partial melting of single minerals up to complete melting and homogenization of target and projectile material can be simulated within one laser-induced melting experiment.

[1] Folco *et al*. (2015) *MAPS* **50-3**, 382–400 [2] Hamann et al. (2013) *GCA* **121**: 291–310. [3] Hamann *et al*. (2014) 77th Meeting of the Meteoritical Society, Abstract #5222. [4] Ebert *et al*. (2014) *GCA* **133**, 257–279.