Damage distributions in ceramics under different shock loadings

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To study evolution of damage spreading in ceramics with propagation of shock wave an explicit failure model is developed and tested. This model is improved version of the implicit failure model early developed by Johnson and Holmquist [1]. Smoothed particle hydrodynamics simulations are performed to optimize the model parameters using the free surface velocity profiles obtained in shock-wave experiments. The simulations reveal the importance of the following factors: 1) the strength of the failed material must be adjusted to ensure the applicability of the failure model to various samples manufactured differently [2] and 2) the inclusion of phase transition with hysteresis is essential for agreement between simulations and experiments for ceramics undergoing a solid-solid phase transition under shock compression [3].

We demonstrate that in the underdriven shockwave regime the spatial distribution of damages changes from a homogeneous damage pattern to regular structures of failure bands after elastic wave splitting from a plastic wave. The band growth is guided by distributions of equivalent stress and shear strength of material within the band tips. But a uniform damage pattern is produced in the overdriven regime at which the plastic shock front overtakes the elastic precursor.

[1] Holmquist T and Johnson G 2006 *Journal of Applied Physics* **100** 093525

[2] Dyachkov S, Parshikov A, Egorova M, Grigoryev S Y, Zhakhovsky V and Medin S 2018 *Journal of Applied Physics* **124** 085902

[3] Grigoryev S Y, Dyachkov S, Parshikov A and Zhakhovsky V 2022 *submitted to Journal of Applied Physics*