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Opinion

# Dynamic Strength of Brittle Mining Solids

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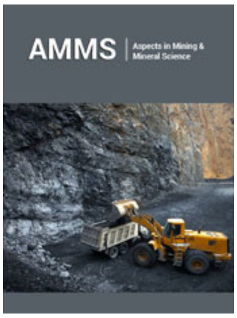


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## Opinion

The initial local dynamic fracture is an important stage of deformation process which defines the macroscopic strength of brittle materials. Nucleation and development of initial sources of damage is closely associated with the local structural instabilities of dynamic deformation process. In their scale, the structural instabilities belong to mesoscale, which supposes that experimental study of the response of material on shock loading should also be carried out at the mesoscale. In the present work, the results of studying the dynamic fracture of typical brittle material, gabbro-diabase, are presented. The goal of research was a determination of the criterions for nucleation of localized structural instabilities as sources of initial stage of dynamic fracture. Shock tests of specimens were performed under uniaxial strain conditions (plane collision) by using light gas gun of 37mm bore diameter. The gabbro-diabase under investigation has the following characteristics: density ρ=3,05g/cm$^3$ and sound velocity Cl=6,25cm/s. The specimens for shock tests were in the form of parallelepiped of 52mm in size and 12.2mm in thick. They were polished and covered with aluminum layer of 25μm, which provides a mirror reflection of laser beam of interferometer from the free surface of target. The local probing of the free surface velocity of target (opposite to loaded surface) by using interferometric technique allows to determine the criterion for initial stage of damage [1,2]. The time resolved free surface velocity profiles were registered with the velocity interferometer, the laser beam of which was focused on the free surface of target up to 60-70μm, so all the local strength characteristics inferred from the velocity profile concerns to mesoscale.

Macroscopically, the threshold for the initial stage of dynamic fracture corresponds to appearance of horizontal steps at the front of compressive pulse. The structure of the shock wave in the form of the free surface velocity profile, $u_{fs}(t)$ is shown in (Figure 1) where a time dependence of velocity variance at the mesoscale-1, D(t), is also presented. The velocity variance is seen to be maximum in the middle of the piece OE and decreases to zero to the beginning of the step EF. The velocity variance, D(t), characterizes the reversible relaxation behavior of medium at the mesoscale-1 (1-10μm). The irreversible displacement of structural element of mesoscale-2 (50-500μm) in the form of step EF begins just at the moment when relaxation of local stresses at the mesoscale-1 is exhausted after what the motion of structural element of mesoscale-2 as a whole occurs. This irreversible motion of meso-2 structural elements means the fragmentation of material. Analogous steps can be found at the rest of the velocity profiles, registered at the impact velocities of 92m/s, 117.5m/s and 224.8m/s. The velocity, $U_{inst}$, corresponding to step EF, defines the structural instability threshold, whilst the presence of oscillations at the plateau of compressive pulse indicates the fragmentation of structure. The shape of the velocity profiles evidence that the spall strength equals to zero for all the shots, which means that fragmentation happens over the total region of impact velocities under consideration. The typical micrograph of inner structure of post-shocked specimen is provided in Figure 2. One can see the numerous cracks surrounding the structural elements. The cracks spread over the target from loaded to free surfaces. In this work, a statistical treatment of dimensions of structural elements after damage of gabbro-diabase targets was performed. The distribution is found to corresponds to hierarchic row $K=L_i/L_{i-1}$ where the similarity coefficient K lies within limits of 1.8-2.5 [3].

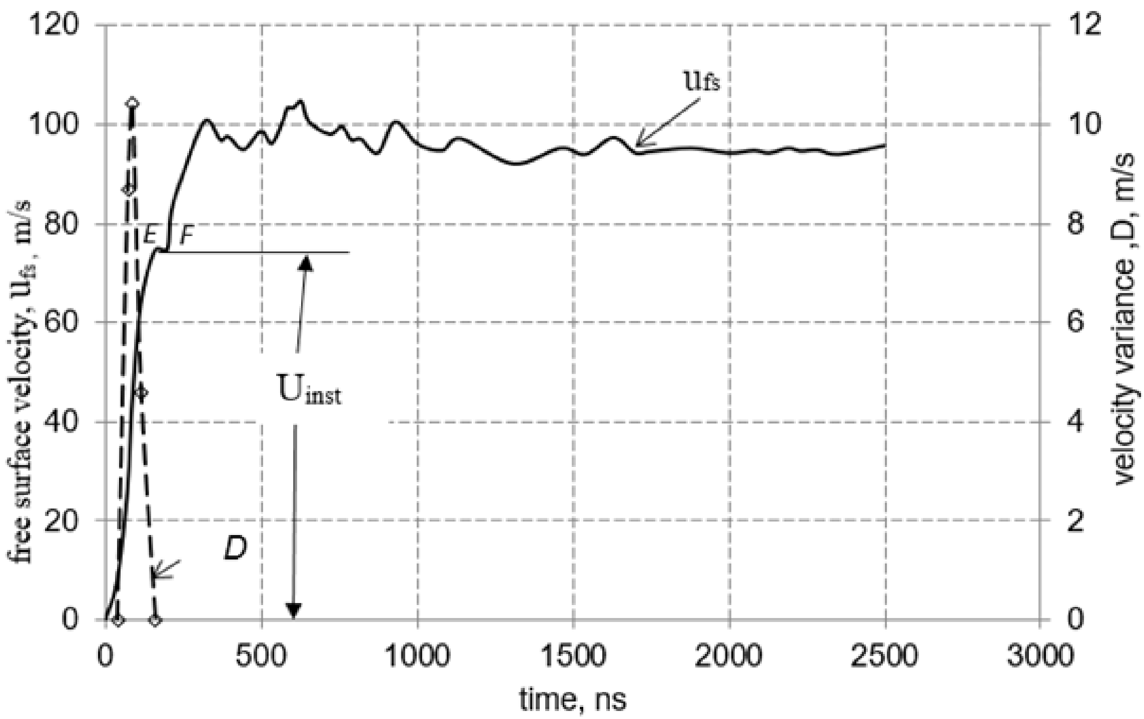


**Figure 1:** Free surface local velocity profile, ufs(t), and velocity variance profile, D(t), for 12mm gabbro-diabase target loaded at the impact velocity of 117.5m/s.

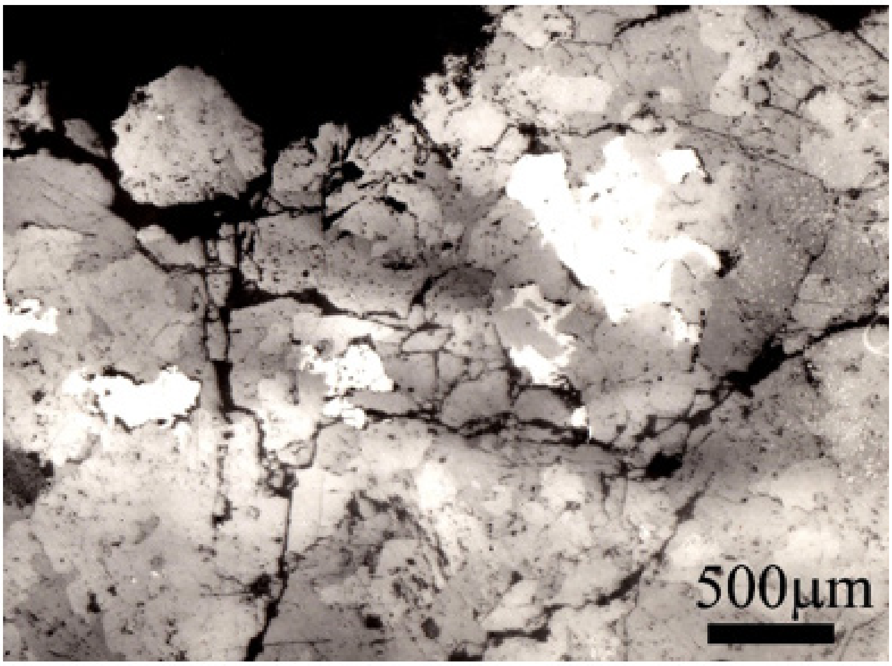


**Figure 2:** Micrograph of cross-section of post-shocked 12.2mm gabbro-diabase target loaded at the impact velocity of 92m/s.

## References


1. Zhu JH, Zhang WH, Xia L (2016) Topology optimization in aircraft and aerospace structures design. Arch Comput Methods Eng 23: 595-622.
2. Christensen P, Anders K (2008) An introduction to structural optimization. Springer, Germany.
3. Brandon WC (2020) Additive manufacturing applications and implementation in aerospace. Master Thesis, MIT, Master of Science in Mechanical Engineering, Massachusetts, USA.
4. Grzegorz M, Emiel VDV, Matthijs L, Hubert G, Fred VK, et al. (2021) Topology optimizastion for additive manufacturing with distortion constraints. Comput Methods in App Mech and Engrg 386: 114095.
5. Akin D, Istemihan G, Oguzhan Y (2021) Design and additive manufacturing of a fatigue-critical aerospace part using topology optimization and L-PBF process. Procedia Manufacturing 54: 238-243.