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Failure waves in shock-compressed glasses

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The failure wave is a network of cracks that are nucleated on the surface and propagate into the elastically stressed body. It is a mode of catastrophic fracture in an elastically stressed media whose relevance is not limited to impact events. In the presentation, main properties of the failure waves are summarized and discussed. It has been shown that the failure wave is really a wave process which is characterized by small increase of the longitudinal stress and corresponding increments of the particle velocity and the density. The propagation velocity of the failure wave is less than the sound speed; it is not directly related to the compressibility but is determined by the crack growth speed. Transformation of elastic compression wave followed by the failure wave in a thick glass plate into typical two-wave configuration in a pile of thin glass plates confirms crucial role of the surfaces. The latter, as well as specific kinematics of the process distinguishes the failure wave from a time-dependent inelastic compressive behavior of brittle materials. The failure wave is steady if the stress state ahead of it is supported unchanging. Mechanism of this self-supporting propagation of compressive fracture is not quite clear as yet. On the other hand, collected data about its kinematics allow formulating phenomenological models of the phenomenon. In some sense the process is similar to the diffusion of cracks from a source on the glass surface. However, the diffusion-like models contradict to observed steady propagation of the failure wave. Analogy with a subsonic combustion wave looks more fruitful. Computer simulations based on the phenomenological combustion-like model reproduces well all kinematical aspects of the phenomenon.