
The Energy Absorption Behavior of Graphene Aerogels

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Abstract

The experimental investigation of the dynamic mechanical behavior of graphene aerogel is still challenging due to its low impedance. The classic one-dimensional stress wave theory for calculating the stress-strain curves and the strain rate data is, therefore, not applicable here. The energy analysis, however, does not require that the specimen be in a state of dynamic stress equilibrium or uniform deformation which are exactly the experimental challenges in the current study. Thus, the present work reports on the preliminary experimental characterization of the energy absorption characteristics of graphene aerogel by using the aluminum alloy (7075-T6) split Hopkinson pressure bar emphasizing the influence of the drying method. The graphene aerogels were synthesized by the sol-gel method and dried, either by supercritical CO₂ drying (SD) or by freeze-drying methods (FD). It was observed that under dynamic uniaxial compression, the SD samples exhibited a negative Poisson's ratio throughout gradual compression. However, FD samples failed by radial shattering without this auxetic behavior. The energy dissipation ratios of SD samples increased from 41% to 73% as expected with the specimen thickness increasing from 3mm to 12mm, being overall higher in comparison with FD samples which rises from 35% to 43%. SD graphene aerogels have a large number of random pores ($\sim 50\text{nm}$), which is beneficial for absorbing the kinetic energy through plastic deformation and pore walls' collapse. By contrast, the FD graphene aerogels' pore walls buckle readily under the impact, and fail due to their ordered porous structure at the micron scale ($\sim 1\mu\text{m}$), which impairs their energy absorption capability.

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