

PROCEEDINGS

Dynamic Compression and Energy Absorption Behaviours of a Nanofluidic Liquid Foam

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ABSTRACT

Intensive dynamic loadings are the main threats to the structural damage of protective structures and inner equipment, which has attracted a lot of attention in the field of advance impulsive resistance. Nanofluidic liquid foam (NLF) has become a novel and efficient energy absorption system due to its reusable energy absorption, ultra-high load transfer, and high energy absorption ratio [1-7]. In order to solve the current problem that the energy absorption mechanism of NLF is still unclear, this paper conducted a systematic experimental study on the dynamic compression and energy absorption behaviours of NLF. The quasi-static cyclic compression experiments with different liquid types and loading rates were carried out, which revealing the effect of solid-liquid properties on the infiltration pressure and clarifying the strain rate insensitivity of NLF. Also, the main parameter properties affecting the energy absorption density and the repeatable usage rate of NLF are obtained. Moreover, the dynamic impact experiments were carried out by a separated Hopkinson pressure bar (SHPB) experimental setup, the influence laws of different loading rates on the macroscopic mechanical response and microscopic infiltration behavior of NLF are discussed. It is found that the mechanical properties of NLF materials under dynamic impact, although still based on their nano-scale solid-liquid infiltration behaviour, are not exactly the same as the influence mechanism under quasi-static conditions. The results also indicate that gas molecules have a similarly significant effect on the liquid infiltration behavior and energy absorption efficiency of the NLF under high strain rate impacts. The research fills the lack of study on dynamic infiltration and energy absorption characteristics, and provides theoretical reference for the research and development of various nanofluid systems.

KEYWORDS

Nanofluidic liquid foam; energy absorption; strain ratio effect; infiltration and exfiltration

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present study.

References:

1. Sun, Y., Xu, J., Li, Y. B., et al. (2013). Experimental study on energy dissipation characteristics of ZSM-5 zeolite/water system, *Advanced Engineering Materials*, 15(8), 740-746.
2. Gao, Y., Li, M., Zhang, H. et al. (2022). Anomalous solid-like necking of confined water outflow in hydrophobic nanopores. *Matter*, 5(1), 266-280.
3. Li, M., Lu, W. (2017). Liquid marble: A novel liquid nanofoam structure for energy absorption. *AIP Advances*, 7, 055312.
4. Aussillous P., Quere D. (2001). Liquid marbles. *Nature*, 411, 924-927.
5. Binks, B. P. Murakami R. (2006). Phase inversion of particle-stabilized materials from foams to dry water, *Nature Materials*, 5, 865-869.
6. Zhao J. B., Liu L., Culligan P. J., Chen X. (2009). Thermal effect on the dynamic infiltration of water into single-walled carbon nanotubes, *Physical Review. E, Statistical, Nonlinear and Soft Matter Physics*, 80 6 Pt 1, 061206.
7. Poynor A., Hong L., Robinson I. K., et al. (2006). How water meets a hydrophobic surface, *Physical Review Letters*, 97, 266101.