The Poker-Chip Experiments of Gent and Lindley (1959) Explained

Aditya Kumar and Oscar Lopez-Pamies*

Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign, IL, 61801-2352, USA
E-mail: pamies@illinois.edu, web page: http://pamies.cee.illinois.edu

ABSTRACT

In this work, we will present simulations generated from a non-conforming finite-element implementation of a recently introduced theory of fracture and healing for elastomers [1, 2] that are aimed at critically examining the "appearance" and subsequent growth of cavities/cracks in the classical poker-chip experiments of Gent and Lindley [3]. The simulations will show that the experimentally observed systematic cascading "appearance" of cavities/cracks around the midplane of the specimens is governed by the randomness of the underlying microscopic defects from which macroscopic fracture nucleates in conjunction with the competition between the ratio of hydrostatic stress to stretch and the toughness of the elastomer. The simulations will also show that the fact that thicker specimens feature a smaller number of nucleated cavities/cracks than thinner ones is governed by the same principles. These results bring resolution to competing views in the literature on these classical experiments: the appearance of cavities/cracks — commonly referred to as cavitation — in the poker-chip specimens of Gent and Lindley is a fracture phenomenon and not an elastic instability.

REFERENCES

[1] Kumar, A., Francfort, G.A., Lopez-Pamies, O. Fracture and healing of elastomers: A phase-transition theory and numerical implementation. *Journal of the Mechanics and Physics of Solids* (2018) **112**:523–551.

[2] Kumar, A., Ravi-Chandar, K., Lopez-Pamies, O. The configurational-forces view of fracture and healing in elastomers as a phase transition. *International Journal of Fracture* (2018) **213**:1–16.

[3] Gent, A.N., Lindley, P.B. Internal rupture of bonded rubber cylinders in tension. *Proc. R. Soc. Lond. A* (159) **249**:195–205