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Nanovoid formation in cross-linked epoxy and poly(dicyclopentadiene) networks during high strain rate deformation ROBERT M. ELDER, DANIEL B. KNORR, JR., JOSEPH L. LENHART, JAN W. ANDZELM, TIMOTHY W. SIRK, US Army Research Laboratory — Cross-linked polymer networks are widely used as structural and protective materials under extremes of temperature, pressure, or strain rate. In particular, substantial effort has been devoted to improving the high strain rate impact resistance of epoxy resins. Although epoxy resins are widely used in applications requiring impact resistance, epoxy resins with the strength and stiffness necessary in structural applications typically have poor toughness. Recent work showed that other chemistries in cross-linked polymers can overcome this trade-off between strength and toughness. Specifically, cross-linked polydicyclopentadiene (pDCPD) was found to have exceptional performance compared to epoxy resins, which is related to the high toughness of pDCPD. Based on the physicochemical properties of epoxy and pDCPD, it was hypothesized that the excellent toughness of pDCPD was due to the formation and growth of nanovoids during impact events. Void growth dissipates energy that otherwise would contribute to failure. We use atomistic molecular dynamics simulations to quantify void formation in these cross-linked polymer networks and to examine the molecular-level properties of the voids. Our findings suggest methods to increase void formation and growth, which may improve toughness.

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