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High-Strain Rate Mechanical Response of Cured Epoxy Networks

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Chemically cross-linked polymer networks are increasingly common in high performance composites, adhesives and other applications involving high-impact loading conditions or ballistic collisions. The mechanical behavior of epoxy and other polymer networks exhibit a strong dependence on strain rate near the glass transition temperature (Tg); however, the elastic modulus at strain rates greater than 10^5 1/s is difficult to capture with experimental techniques. We present computational results of Di-Glycidyl Ether of Bisphenol A (DGEBA) and Jeffamine diamines (D230) from molecular dynamics simulation, which is intrinsically well-suited to model material deformation at high strain rates. Our results show that the experimental Tg can be reproduced from molecular dynamics, and the Williams-Landel-Ferry equation is useful in rationalizing the shift of Tg due to fast annealing and high strain rates. Temperature sweeps of elastic modulus show the glass-rubber transition to occur over a significantly wider temperature range compared with experimental measurements at low strain rates.

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