Soft Elastomers for Impact Protection

C.M. Roland

Naval Research Laboratory
Washington DC 20375-5342
and
Nova Research Inc.
Alexandria, VA 22308

The property changes accompanying the transition of a rubbery polymer to a glass are spectacular – small variations in external conditions can alter the time scale for molecular motions from nanoseconds to a duration exceeding the human lifespan – yet transpire without any obvious change in the arrangement or interactions of the molecules. This remarkable behavior presents both research challenges and technological opportunities. For a number of years we have been studying glass-formation, and how to exploit the phenomenon to develop elastomeric coatings that make armor lighter and more effective. The specific requirement of the polymer is that the frequency of its local segmental dynamics correspond to the impact frequency (*ca.* 10^5 s^{-1}). When this condition is satisfied, the rubbery coating transiently becomes very hard and absorbs substantial energy, mitigating the effect of the impact.

Fundamental studies underlying our armor development include measuring the segmental dynamics of polymers over broad frequency ranges at high pressures (up to 6 GPa), and an analysis, originally applied to automobile tires, to determine the control parameter for the viscoelastic response of materials under impact. The utility and limitations of laboratory experiments to predict the ballistic performance of materials will be discussed.

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Email address: croland52@gmail.com (Mike Roland)