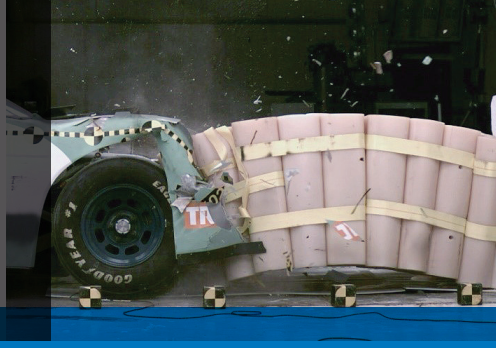
HYPERELASTIC MATERIALS



Many common materials, such as rubber or tissue, have nonlinear elastic behavior, where the deformation is not proportional to the applied stress. Battelle has been working with a specific class of materials that have this nonlinear behavior. These hyperelastic materials have properties that vary with the strain rate, or how rapidly the material is deformed.

Although these hyperelastic materials have many interesting properties, Battelle has focused specifically on their ability to absorb or redirect energy. By focusing on how the material absorbs and releases energy, we are able to improve safety and security of our military and the general population.

HOW IT WORKS

The hyperelastic properties exist in polyurethane polymers that have very unusual internal bonding. Although the specific formulations that create the properties are new, we create these formulations using mixtures of monomers and oligomers that are commercially available. By working with materials that are commercially available, it will be easy to make the hyperelastic materials at the scale needed for real-world applications.

OUR WORK IN ACTION

Although there are many potential applications of this technology, we can discuss two specific applications where these materials have been applied.

1. Multi-impact Crash Barrier

Standard crash barriers can be both hazardous and costly. When a car hits the metal barrier, the impact is absorbed by deforming the barrier. Until the barrier is replaced, it no longer provides any protection, while replacing it is costly.

Battelle developed a concept for a multi-impact crash barrier based on hyperelastic materials. The key feature to this design was that the barrier would restore itself to its original shape, but at a much slower speed than it absorbs the impact (otherwise the vehicle would be flung out into traffic). After creating a nominal design for the system, Battelle formulated the hyperelastic polyurethane that enables the design.

The multi-impact crash barrier is currently manufactured and in use on highways. It's at a Technology Readiness Level (TRL) 9 in this application.

2. Armor

One of the major challenges facing lightweight armor is the need to survive multiple strikes in the same location. This translates to a need for a material that can rapidly absorb a large amount of energy at a high strain rate. Using a similar process, Battelle created a nominal set of requirements for this hyperelastic material, then formulated a new aliphatic material that could meet these challenging requirements using commercially available monomers and oligomers. Armor panels were fabricated, and ballistic testing demonstrated the multi-strike capability.

The armor is at a TRL 5 and has been demonstrated in simulated field environments. Further development is needed for field deployment.

HOW WE DIFFER

These two examples illustrate the key to Battelle's hyperelastic technology, which is the definition of materials requirements from a nominal design, followed by formulation of a material to meet these specific application requirements. The incorporation of this tailored material provides the differentiation in the final product.

OTHER USES

There are multiple fields beyond the two presented here that can leverage materials with tailored energy absorption properties to provide new function or differentiation from competitors. Possible applications include:

- Impact or vibration dampening applications, such as construction, tools, automotive, oil rigs, etc.
- Protection from impact.

800.201.2011 | solutions@battelle.org | www.battelle.org

BATTELLE
It can be done

ID 687 05/19