# Pacific Northwest National Laboratory

Operated by Battelle for the U.S. Department of Energy

# Structural Reliability of Lightweight Glazing Alternatives

## Importance of Our Work

At Pacific Northwest, researchers developed a lightweight glazing that meets the PNGV 30% weight reduction target, structural integrity, and cost. It prevents injury during crashes and/or occupant ejection during rollover. We've provided a predictive and robust analytical tool for aiding in the design of lightweight automotive glazing alternatives.

## Project Benefits

- Reduce energy consumption
- Reduce vehicle emissions

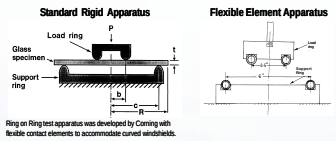
## Project Participants

Pacific Northwest National Laboratory

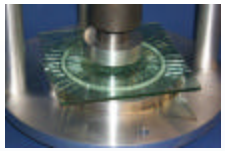
PPG Industries

Visteon Automotive Systems

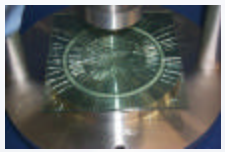
Ford Motor Company



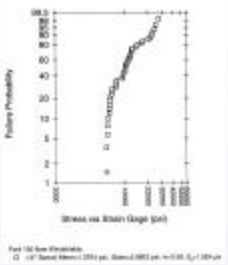

Unique Flexible Element Ring-on-Ring Apparatus Developed. Allows determination of strength of curved glass specimens.



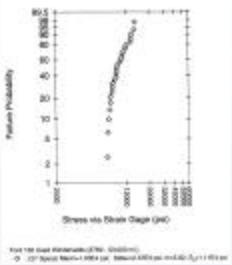
Photograph of the Ring-on-Ring Apparatus during a test



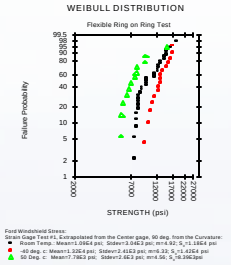
Photograph of a fractured specimen after Ring-on-Ring test



Strength of new windshields – failure probability



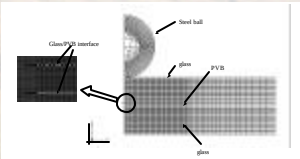
Strength of used windshields – failure probability



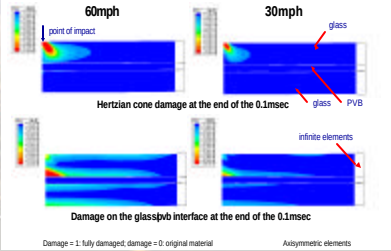

Effects of temperature of windshield strength

## Numerical Modeling of High Speed Impact

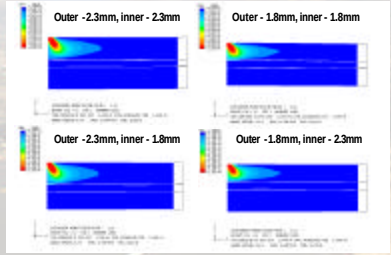
Finite element models were developed that describe the impact of projectiles with windshields. The model captures the effect of two independent glass layers separated by a layer of PVB material. The model predicts the levels of stress induced in the materials during an impact event, and calculates an accumulated damage developed during impact. The basic finite element model is shown below with typical damage prediction results. The level of damage ranges from zero to one, with one representation a destroyed or fracture region.




Half symmetry representation of the finite element model



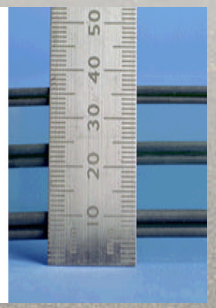

The effect of projectile speed on windshield impact and damage

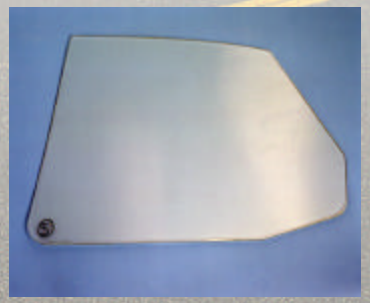



The effect of glazing thickness and design on windshield impact and damage.

## Fabrication of Lightweight Glass

The lightweight glass materials are being investigated in windshields, sidelights, and backlights. The populations of samples include laminated (safety) glass samples of varying thickness and asymmetric construction down to a minimum single ply thickness of 1.6mm.

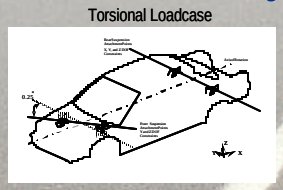




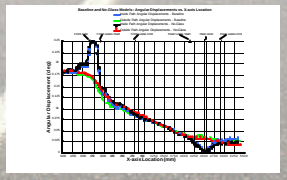
## Contribution of Glazing to Lightweight Vehicle Torsional Rigidity

The contribution of the glazing to the torsional rigidity of the Ford P2000 aluminum intensive vehicle was evaluated. The finite element evaluation shows that the glazing raises the autobody torsional stiffness 12.4%. The results also show that the glazing thickness may be reduced by as much as half and cause only small decreases in torsional rigidity.

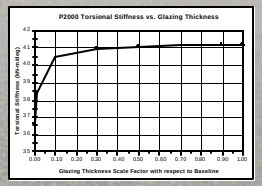
Ford P2000 body-in-white finite element model




Torsional load case model used to evaluate stiffness



Torsion of the P2000 vs. position along its length with and without glazing




Torsional stiffness of the Ford P2000 vs. glazing thickness

DOE-EE-OTT, Office of Advanced Automotive Technologies