AN INVESTIGATION OF SMALL MOLECULE PENETRANTS INTO TRANSPARENT ADHESIVES

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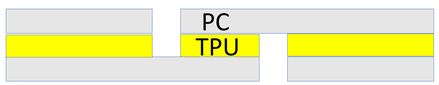
Introduction

- Transparent armor laminates are important for protecting soldiers in combat scenarios
- Current adhesives in transparent armor laminates have shown failure when exposed to chemicals
- Better understanding the affect of these chemicals can give insight on future adhesive designs

Methodology

- Adhesive thermoplastic polyurethanes (TPU) were exposed to water and diisodecyl phthalate (DIDP)
- Bulk TPU was then tested to see the impact of the materials
- PC-TPU lap shear samples were made and exposed to measure the affects on interfaces



PC-TPU Lap Shear Sample Diagram

- Molecular modeling simulation were then made to gain insight into material behavior

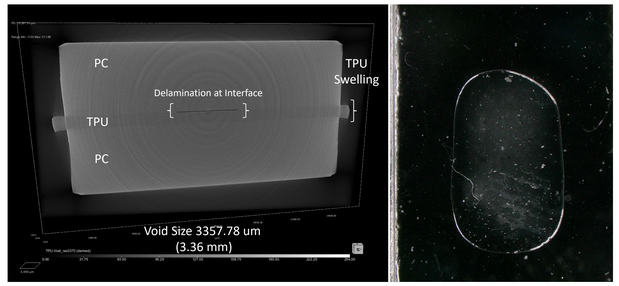
Chemical Exposure

- Both water and DIDP are adsorbed by the DIDP in bulk and lap shear samples
- DIDP has a much higher saturation point than water and causes pronounced swelling

Solvent	Temperature (C)	Saturation Mass %	% Volume Change
DIDP	25	30.78%	33.97%
DIDP	40	39.26%	42.18%
DIDP	70	59.00%	60.65%
Water	50	1.97%	1.32%

TPU Saturation Results

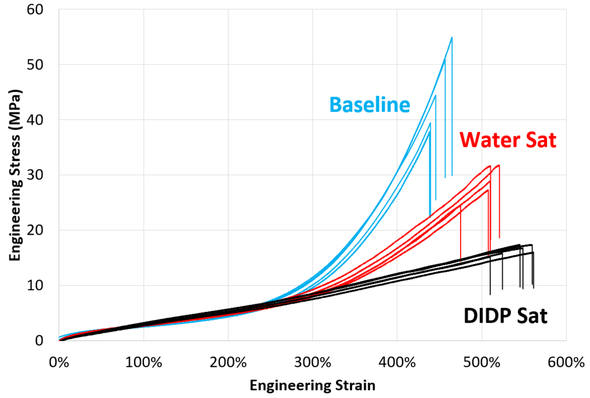
- Lap samples exposed to DIDP swell enough to cause delamination in samples at the interface



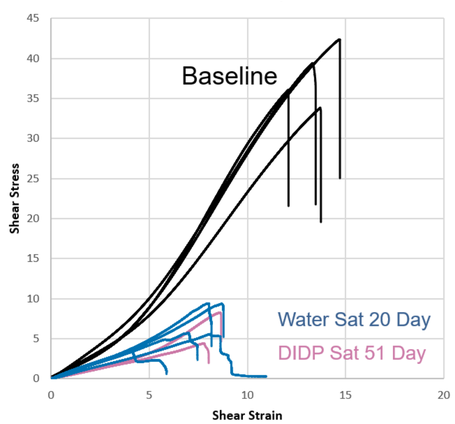
CT and Image of DIDP Induced Lap Shear Failure

Experimental Results

- Both shear and tension experiments were performed on the dry and saturated TPU



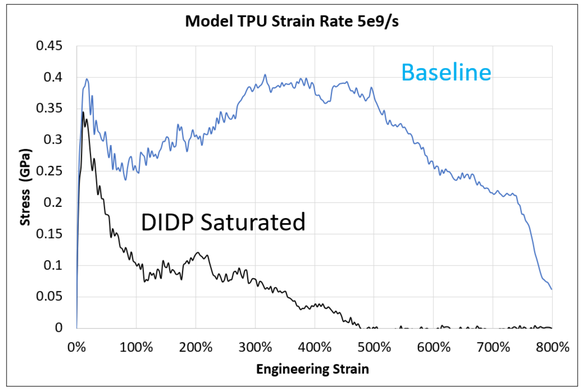
Tensile Results Conditioned TPU



Lap Shear Results Conditioned TPU

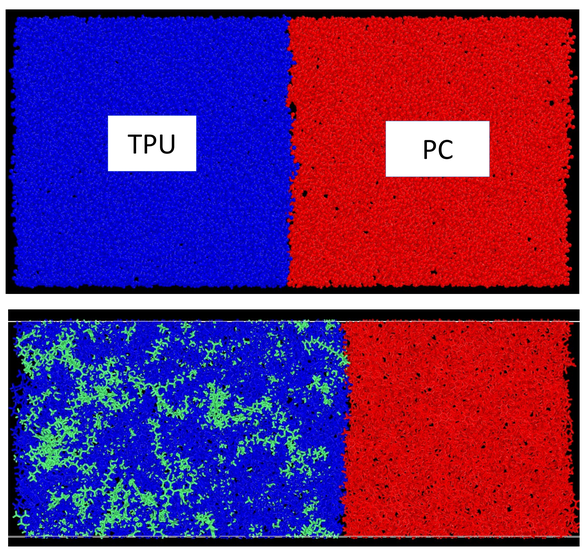
Molecular Modeling

- TPU, PC and chemical penetrants are modeled and mixed to amounts found in diffusion simulations
- Bulk tension simulations are then done to measure the difference caused by the small molecule penetrants



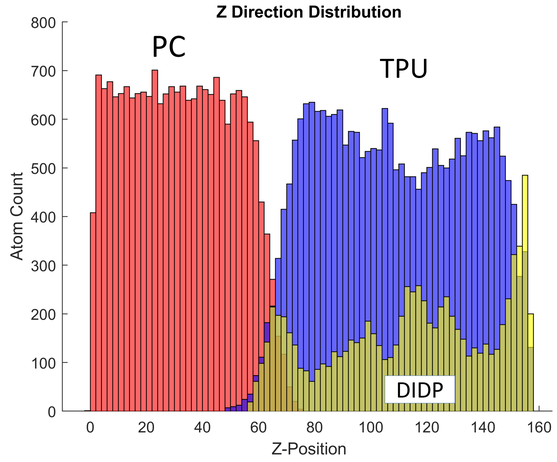
Tension Results of Bulk TPU Simulations

- To measure interface behavior the different materials are brought together and allowed to mix
- The chemical penetrants must be added during model construction so monitoring their distribution is important



Baseline vs DIDP Saturated TPU-PC Simulation

- The mixing of the molecules can be tracked to see where the DIDP accumulates



Distribution of molecules after mixing simulation

Future Work

- Fishing interface simulations quantifying difference in baseline vs saturated conditions
- TPU simulations of all hard and soft segment molecules to measure their affect on Tg, Modulus, etc.
- Analyzing bond breakage vs chain pull out on interface simulations

Acknowledgements

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