Performance of Liquid Benzoxazine-PEG Blend Resin Systems for Potential Industrial Composites Processing

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Applications of Blends in Aerospace

- Benzoxazines are cost competitive and perform better than phenolics, which are currently the standard in aerospace.¹ (Figure 1)
- Benzoxazine prepregs can be manufactured through hot melt or solvent based prepaing. Organic solvents impart health and financial risks.

![Figure 2](Image 33x116 to 301x208)

Figure 2. Relevent chemical structures.

<table>
<thead>
<tr>
<th>PEG wt.%</th>
<th>90 %</th>
<th>80 %</th>
<th>70 %</th>
<th>60 %</th>
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</thead>
<tbody>
<tr>
<td>BO/PEGOH</td>
<td>50, 25, and 10 PEG wt.% from left to right.</td>
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Generational of pHSA Catalyst

- The grafting of PEG was determined with SEM (Figure 6).
- FTIR spectra of cured blends of BO with (a) PEGOH (b) PEGOTs. In panel (a), the first peak signal for a pHSA thermogram. (iv) Trace plot of the signal at 885 cm⁻¹ (a) TGA-MS spectrum scan for m/z 91, and (ii) a DSC thermogram of the 0.5 PEGOTs/BO blend.

![Figure 3](Image 27x1553 to 952x1832)

Figure 3. Trace plots for 50 µH stretch at BBS cm⁻¹ from TGA-FTIR of BO blends with (a) PEGOH (b) PEGOTs. (i) Release of PEG as determined by TGA and (ii) a DSC thermogram of the 0.5 PEGOTs/BO blend.

Reduced Curing Temperatures of PEGOTs Blends

- In Figure 7, pieces of fiberglass were loaded with PEGOT/BO blends and partially cured at a reduced temperature of 275 °C.
- Core studies were performed with DSC of BO blends with PEGOTs/BO/PEGOH and PEGOTs/BO/PBS.
- Figures 8a and 8b show a linear trend of decreasing cure temperature with increasing PEGOTs content.
- In Figure 8c, the percent cure was larger than theoretical, possibly due to a more complete cure from the catalyst.

![Figure 7](Image 972x1273 to 2797x1832)

Figure 7. Cured fiberglass loaded with PEGOTs/BO blends at 50, 25, and 10 PEG wt.% from left to right.

![Figure 8](Image 99x271 to 1148x573)

Figure 8. DSC cure study from 70 to 260 °C of quenched blends as a function of PEG concentration. (a) Onset and (b) maximum of benzoxazine cure temperature. (c) Cured fiberglass loaded with PEGOTs/BO 3/4/5/6/7 blends as a function of PEG concentration. (d) Weight Percent of PEG Content (%) 50, 25, and 10 PEG wt.% from left to right.

Future Work

The future applications of this project include the addition of flame retardants to blends to reduce the effect of PEG's flammability. The wetting out and loading of blends onto fiberglass will be investigated to evaluate composite materials. Mechanical testing will be performed on composites to determine the tunability of the properties by PEG extraction with water or chloroform.

References