INTRODUCTION

- Polymer matrix composites are being used in high-temperature applications such as engine components and aircraft structures.
- Cyanate ester based composites are promising due to excellent properties (High $T_g$, low shrinkage, thermally stable).
- Long term use in extreme environments leads to decrease in composite properties.
- Project Goal:
  - Use nanoclay particles to reduce the rate of thermo-oxidative decomposition and microcracking of cyanate ester resins composites.

PRIOR FINDINGS

- Nanoclays act as catalysts, increasing the rate of cure and decreasing the maximum cure temperature.
- Nanoclay composites have less weight loss and higher fracture toughness after thermal aging than neat system.

PREPARATION OF MATERIALS

- Resin mixture:
  - Modified cyanate ester resin (RS-9D) mixed with organically modified montmorillonite clay by high shear mixer.
- Composites:
  - Uni-directional and Quasi-isotropic panels made from prepreg of IM7 carbon fiber and resin mixtures.
- Thermal Aging:
  - Samples were aged in air at 260 °C.

EFFECTS OF NANOCLAYS – SHORT BEAM SHEAR

- Phosphonium and Imidazolium had highest strength retention post-aging.
- By 2000 hrs, all samples had lost most shear strength, although neat resin samples were lowest.

EFFECTS OF NANOCLAYS – OPEN-HOLE COMPRESSION

- For each system, the compressive strength decreased with increased aging.
- Clays have no significant impact on thermal degradation.

EFFECTS OF NANOCLAYS – MICROCRACKING

- Unaged samples had transverse cracks in center due to residual thermal stresses.
- Microcracks more prevalent in clay samples than neat.
- Cracks form in surface layers due to thermal degradation.
- Control sample most resistant to crack penetration.

CONCLUSIONS

- Short beam shear results showed modest improvement in property retention for imidazolium and phosphonium nanoclay.
- Open hole compression testing showed that all had similar decline in properties, with no clear benefit for clay systems.
- Transverse microcracks present at center of unaged control composite samples.
- Composites containing nanoclays have higher crack density at center layer than the unfilled control system, suggesting that agglomerates of clay filler may act as flaws that initiate transverse cracking.

ACKNOWLEDGEMENTS

This work is supported by AFOSR STTR (Award TSI-2248-05-72681)