SAND2022-13525C

Influence of h-Boron Nitride on the thermo-mechanical properties of out-of-autoclave silica fiber reinforced phenolic composites

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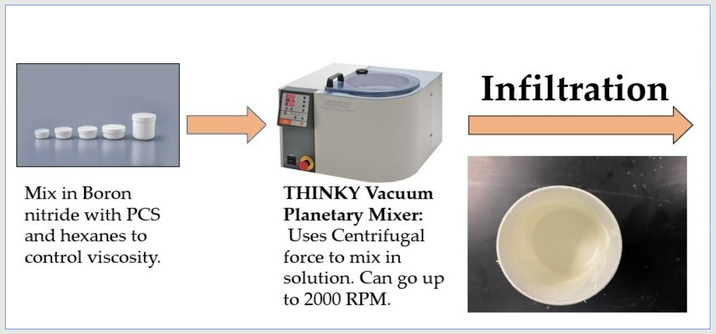
Incorporating nanoparticle in fiber reinforced composite can increase functionality and performance

Directionally oriented fiber-reinforced composite materials are increasingly finding applications, both as structural materials and as ablatives, for thermal protection systems. Phenolic resin composites with carbon or silica fibers possess excellent ablative properties and can be used in thermal protection systems as engine components or heat shields. Although silica/phenolic composites provide excellent thermomechanical or mechanical properties, numerous applications and fields demand improved mechanical behavior as well as the presence of additional properties such as thermal conductivity, radiation tolerance, and optical transparency. In this study, boron nitride (BN) nanoplatelets were added to silica fiber reinforced phenolic composites to study the impact of boron nitride loading on the subsequent mechanical, thermal, and thermomechanical properties. A series of laminates were made with varying loadings of BN (0 vol%, 5vol%, 10vol%) using compression molded out-of-autoclave processing. The relationship between BN loading and mechanical properties was determined via three-point bend testing and short beam shear testing. The fracture properties were analyzed using optical and scanning electron microscopy. The thermal properties were investigated using thermogravimetric analysis and laser flash analysis. Finally, the thermomechanical properties were explored using dynamic mechanical analysis.

Nanoparticle incorporation into a fiber reinforce composite

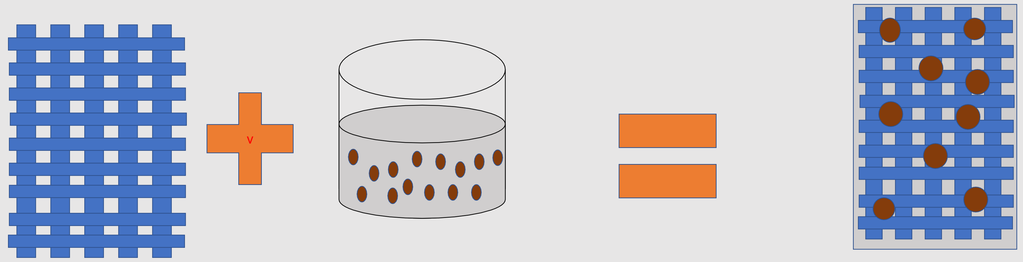
Polymer Slurry:



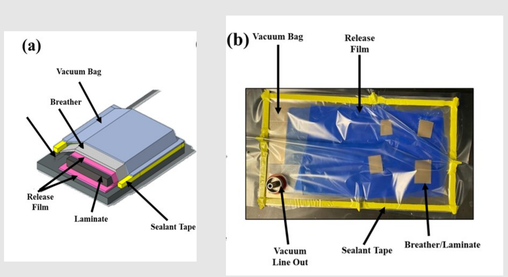
Mix in Boron nitride with PCS and hexanes to control viscosity.

THINKY Vacuum Planetary Mixer: Uses Centrifugal force to mix in solution. Can go up to 2000 RPM.

Continuous Fiber Prepreg Processing
Polymer Infiltration in Fiber mat Utilizes Slurry of Polymer Precursor and Nanoparticles

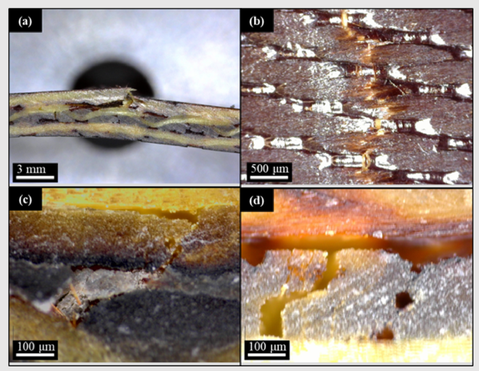


out-of-autoclave method:
-Hydraulic Press.
-2 pounds of pressure was added
Set both platens to 250°F, after platens are at temperature change temp to 325 °F
Once internal temp reaches 230 °F apply 16000 pounds of pressure.
Completed at temp 285 °F

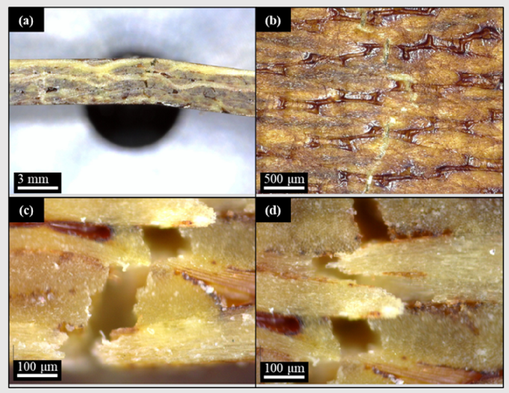


Laminate Fabrication Compression molded prepreg process was utilized to manufacture laminate

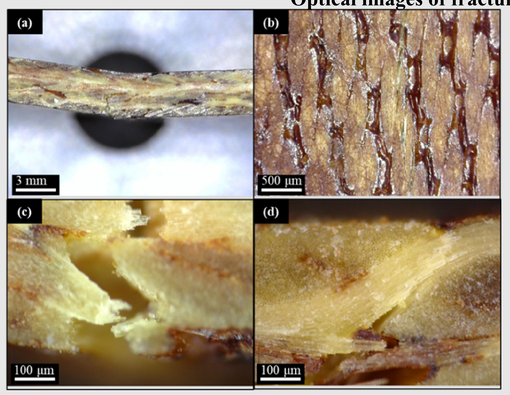
Post three-point bending as a function of BN loading



Optical images of fractured 0 vol% BN samples

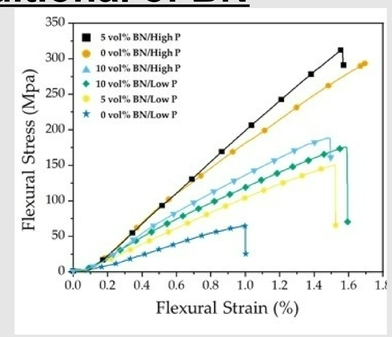


Optical images of fractured 5 vol% BN samples



Optical images of fractured 10 vol% BN samples

Mechanical Property with the additional of BN



Conclusions

. In this study, the improvement of the thermal, mechanical, and thermo-mechanical properties of silica/phenolic composites through the addition of nanofillers was investigated. The composites were produced using compression molded prepregs as the fabrication method with BN nanoplatelets as the filler material. This work demonstrates the overall promise of BN as a solution for boosting the mechanical and thermal properties of polymer nanocomposites but suggests that either functionalization or modified processing techniques are needed to overcome agglomeration, incompatibility/weak interactions with the polymer matrix in order to be realized as a viable solution.

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