Epoxy-PVB composite binder reinforced with nanostructures of WS_2

CertBond
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OBJECTIVE

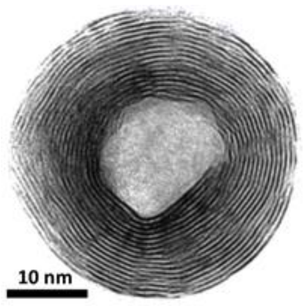
The aim of this research was to examine the possibility of reinforcing a polymeric binding system epoxy/PVB with small concentrations of WS_2 nanostructures (inorganic fullerene-like nanoparticles, IF, and nanotubes, INT) for the possible implementation as a binder in composite structures for aircrafts construction and other demanding applications, and as a bonding interface for various types of materials.

Poly(vinyl butyral), PVB, is a thermoplastic elastomer often used as a good impregnating matrix, with good adhesion properties. It is usually added to brittle resins, such as phenolic or epoxy, in order to enhance their toughness and ductility. So far, IF-WS_2 and INT-WS_2 have shown outstanding mechanical resistance themselves, but also as reinforcing fillers in polymer matrices.

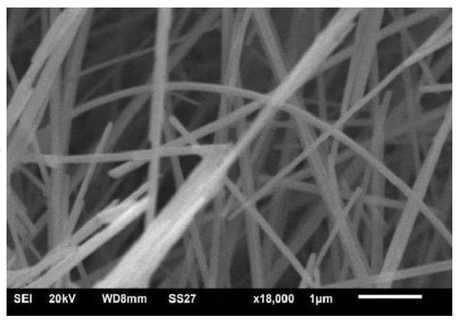
MATERIALS AND METHODS

- PVB powder Mowital B30H (Kuraray GmbH),
- Epoxy resin (Hexion aero),
- IF-WS_2 and INT-WS_2 (NanoLub, ApNano Israel),
- ethanol 96%.


PVB



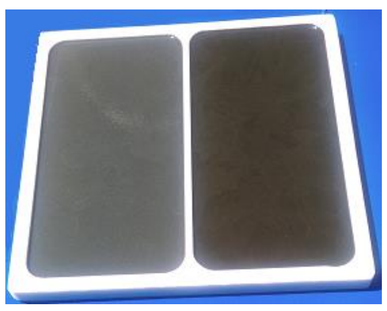
IF- WS_2



INT- WS_2


Ultrasonication

PVB was dissolved in ethanol in which IF-WS_2 or INT-WS_2 were ultrasonically dispersed; then this solution was mixed with epoxy resin component A, and after homogenization component B was added and mixed. The mixture was cast into flat moulds and dried until ethanol evaporated. Thick film samples were obtained and specimens for mechanical tests and other analyses were cut out. Also, sample PVB/epoxy without WS_2 was made.

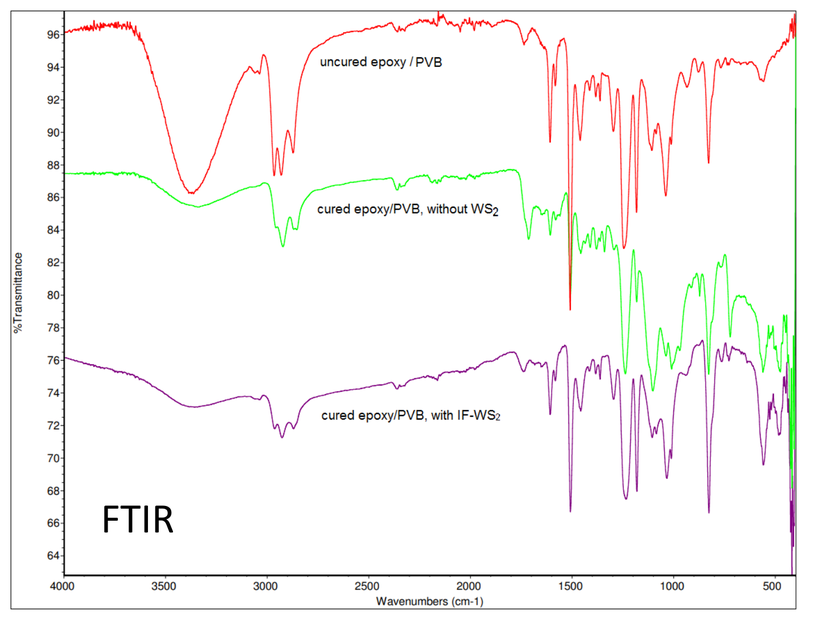


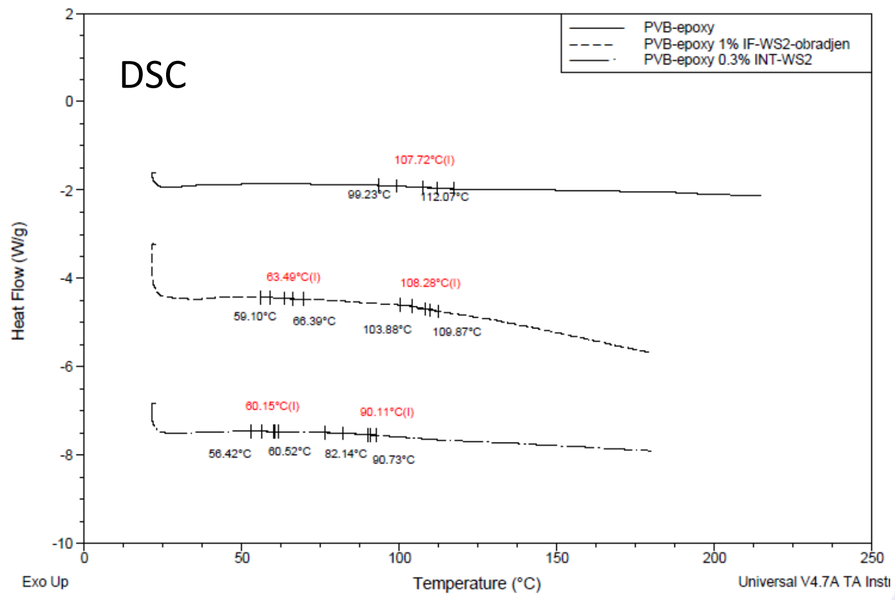
Nanostructures were observed using SEM microscopy to analyze their morphology and size before the incorporation in the composite binder and after composite preparation and curing, in order to determine the uniformity of their dispersion in it.

FTIR technique was used to confirm the reaction between PVB and epoxy, as well as to confirm the chemical inertness of the nanofiller with the resin system.

DSC was used to determine the glass transition temperature of the composite and increased thermal resistance was observed with IF-WS_2.

The tensile test was performed and it showed that IF could not have positive effect on the tensile strength, due to their shape, except on the ductility, i.e. on the increase of the elongation at break (for 64%); so with their addition other tensile strength parameters decreased. On the other hand, INT had a positive effect: they caused a significant increase in elongation at break (for 96%) and increase in the absorbed deformation energy U_T.





Sample	F_{max} [kN]	R_m [MPa]	E [GPa]	ε [%]	U_T [MJ/m^3]
without WS_2	170.250	14.853	48.533	0.137	1.647
IF-$WS_2$1 mas.%	127.125	9.113	16.078	0.225	1.480
INT-WS_2 0.3mas.%	128.200	9.562	14.167	0.269	1.743

CONCLUSION

The new composite binding system was successfully reinforced with IF and INT-WS_2m, so it might be applied in laminated composites and as a bond for structures and materials for demanding exploitation conditions, such as: aerospace, nautical, automotive and construction, sports and protective equipment, etc.

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