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Materials Science & Technology

LECTURE

State of the Art High Performance Polymeric Composite for Future Generations Nuclear, Aviation and Space

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Moderator	Dr. Saeidi Fatemeh, Empa Thun
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Abstract	see page 2

The language of the presentation is English
Free entrance, guests are welcome

State of the Art High Performance Polymeric Composite for Future Generations Nuclear, Aviation and Space

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And

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Abstract:

This presentation highlights rationale of high performance polymeric composites for its essential application for nuclear, aviation and space. Therefore, the effect of radiation, chemical and thermal environments on mechanical and thermal properties of high temperature resistant polymers such as Polyetheretherketone (PEEK) and Polyether Imide (PEI) composites, which could prove to be an alternative material as container for long term storage of nuclear wastes. In addition these high performance polymeric composites will have significant application for structural application in respect of future generation aviation and space. Therefore, the composites were exposed to space radiation related to Low Earth Orbit (LEO) and Geo Synchronous Earth Orbit (GEO). The tests are conducted on specimens made from PEEK and PEEK reinforced with carbon short fiber. The specimens are subjected to radiation doses, equivalent to the cumulative dosage for 500 years followed by exposure under highly corrosive and thermal environments. Studies under optical microscopy reveal that the dispersion of carbon short fiber in the PEEK and PEI Composites is significantly uniform. Differential Scanning calorimeter (DSC) and Thermogravemetric analysis (TGA) indicates that there are no significant changes in thermal properties of PEEK composite when exposed to aggressive environments. It is further observed that there are no significant changes in mechanical properties of the composite after exposure to radiation and thermo-chemical environment.

This presentation essentially highlights scientifically development of novel high performance fire resistant polymeric nano composite in respect of its orientation towards future generation aerospace. Therefore, an attempt has been made to increase thermal stability and fire

resistivity of phenolic/cotton fabric reinforced polymer (FRP) composite which is desirable for aircraft interior. Atmospheric pressure plasma treatment (APPT) over the phenolic FRP composite surface enhanced the adhesion characteristics between the polymeric interfaces. The phenolic FRP is subsequently coated with calcium silicate dispersed polybenzimidazole (PBI) composite in order to escalate the thermal stability and fire resistance property. Thermo-gravimetric (TGA) analysis reveals that coated FRP shows significantly better thermal stability in comparison to uncoated phenolic FRP. There is a significant increase in the limiting oxygen index (LOI) characteristics of coated FRP when compared to the uncoated phenolic composite resulting in considerable improvement in fire resistivity of the polymer.

This presentation demonstrates deposition of copper and titanium nitride on polymeric composite using Physical Vapour Deposition (PVD) to increase thermo-electrical properties of the composite and deposition of silver using Chemical Vapour Deposition (CVD) on carbon nano fiber to increase electrical conductivity of epoxy adhesive. Physico-thermal characteristics of the basic and conductive polymeric composite and adhesive were characterized using Field Electron Scanning Electron Microscopy (FESEM), Fourier Transform Infrared Spectroscopy (FTIR) and Thermal Gravimetric Analysis (TGA). Electrical conductivity of the basic and conductive composite and adhesive were determined using the Four Probe Method of Resistivity Measurement. It is observed that thermal properties and electrical conductivity of the composite and adhesive increased significantly due to the copper and titanium nitride deposition. The basic and conductive polymeric composite were subjected to high current and temperature to simulate the effect of a lightning strike. It is observed that there is a severe damage of basic polymeric composite compared to conductive polymeric composite, resulting in significant deterioration of mechanical properties. The conductive adhesive would be useful for satellites application to dissipate space charge.