World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:13, No:08, 2019

MXene-Based Self-Sensing of Damage in Fiber Composites

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Abstract : Multifunctional composites with enhanced strength and toughness for superior damage tolerance are essential for advanced aerospace and military applications. Detection of structural changes prior to visible damage may be achieved by incorporating fillers with tunable properties such as two-dimensional (2D) nanomaterials with high aspect ratios and more surface-active sites. While 2D graphene with large surface areas, good mechanical properties, and high electrical conductivity seems ideal as a filler, the single-atomic thickness can lead to bending and rolling during processing, requiring post-processing to bond to polymer matrices. Lately, an emerging family of 2D transition metal carbides and nitrides, MXenes, has attracted much attention since their discovery in 2011. Metallic electronic conductivity and good mechanical properties, even with increased polymer content, coupled with hydrophilicity make MXenes a good candidate as a filler material in polymer composites and exceptional as multifunctional damage indicators in composites. Here, we systematically study MXene-based (Ti_3C_2) coated on glass fibers for fiber reinforced polymer composite for self-sensing using microscopy and micromechanical testing. Further testing is in progress through the investigation of local variations in optical, acoustic, and thermal properties within the damage sites in response to strain caused by mechanical loading.

Keywords : damage sensing, fiber composites, MXene, self-sensing
Conference Title : ICCM 2019 : International Conference on Composite Materials
Conference Location : Amsterdam, Netherlands
Conference Dates : August 06-07, 2019