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Enhanced thermo-mechanical stiffness, thermal stability, and fire retardant performance of surface-modified 2D MoS2 nanosheet-reinforced polyurethane composites

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ABSTRACT:

This article reports new-generation 2D-MoS_2 nanosheet-containing polyurethane (PU) composite materials with improved thermo-mechanical stiffness, thermal stability, and fire retardation properties. The surface of 2D-MoS_2 nanosheets is modified with melamine (M-MoS_2), and then PU composites with varying M-MoS_2 loadings are synthesized using an in situ polymerization method. During polymerization, 3-amino-propyl-trimethoxy silane is introduced to create silicate functionality on the PU chains, which further improves the compatibility between PU and M-MoS_2. Microscopy studies confirm the distribution of highly intercalated and agglomerated M-MoS_2 nanosheets in the PU matrix. The PU composite containing 5 wt% M-MoS_2 shows a 65% higher storage modulus (at 30 °C) than that of pure PU. The thermal stability of pure PU is significantly improved (62 °C) after composite formation. Thermogravimetric analysis in combination with FTIR spectroscopy shows that the PU/M-MoS_2 composites release less toxic gases during thermal degradation compared to pure PU. Moreover, the composite containing 5 wt% M-MoS_2 shows improved fire retardation properties, with 45% and 67.5% decrease in the peak heat and total heat release rates, respectively, as compared with those of pure PU. In summary, 2D-MoS_2 is shown to have potential as an advanced nano-filler to obtain stiffer PU composite with improved fire retardant property for structural application.