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Environmental Photonic Energy Manipulation with Fire Safety Coatings

ABSTRACT

Through incorporating thermochromic microcapsules, boron nitride nanosheets and montmorillonite nanosheets, an advanced polyurea-based composite coating was fabricated. The chameleon-inspired color change and admirable IR emissivity were achieved in the composite coatings, which adaptively adjusted the solar absorption and reflection in daytime while enabling radiative cooling throughout the day. The montmorillonite and BN nanosheets formed a ceramic protective layer and suppressed combustion behavior of polyurea coatings. In this work, we firstly introduced Si-O and B-O bonds onto the surface of thermochromic microcapsules (TCMs) to decrease their fire hazards, by synthesizing a Si/B-containing shell. Then, we further combined BN and montmorillonite (MMT) nanosheets with polyurea (PUA) resin to prepare flame-retardant composite coatings, by a solvent-free approach. Such designed composite coatings would spontaneously adjust their absorption and reflection of solar light upon the critical change of environment temperature. Meanwhile, the synergistic effect of BN and MMT nanosheets can suppress the fire hazards of PUA coating. More importantly, it is expected that the hydroxyl group of MMT nanosheets and the amino group of BN nanosheets, as well as the carbamido group of PUA molecule will affect the C—O—C bonds to increase the dipole moment, and support more IR emission [1,2]. After all, the integration of chameleon-inspired, dipole moment-increasing, and fireretardant strategies significantly promotes the practical application of radiative cooling coating [3], by meeting the aesthetic demand, admirable IR emissivity, and high fire safety.

Keywords: flame retardancy, IR emissivity, radiative cooling, thermochromic coating

BIOGRAPHY

Prof. Bin FEI obtained BSc (1996) from the University of Science & Technology of China and PhD (2003) from the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences. After postdoctoral researches, he joined ITC of PolyU in 2010, and became full Professor in 2023. His current research interests fall in functional fashion and smart yarn, regenerative biomaterial and green nanotechnology, biomimic catalysis and sustainable energy.