Fabrication and performance of anti-migration antioxidant intercalated layered double hydroxides for polypropylene composites

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Abstract:

Hindered phenolic antioxidants have gained widespread recognition and application in enhancing the heat resistance and oxidative aging performance of polypropylene (PP) composites. However, the use of low molecular weight antioxidants poses certain challenges. These antioxidants have a greater tendency to volatilize, migrate, and be extracted from PP or PP-based products. Such behavior directly diminishes the anti-thermal oxidative aging efficacy of PP and its composites, and additionally presents a risk of contaminating food or drugs when used in packaging [1]. Layered double hydroxides (LDHs) are highly desirable as antioxidant protection materials due to their adjustable compositions (M^{2+} and M^{3+}) within the host sheet, replaceable interlayer anions (A^{n-}) in the interlayer region, and adaptable charge density (M^{2+}/M^{3+} ratio). Consequently, it is plausible to inhibit the migration of antioxidants utilizing host-guest interactions and supramolecular forces by intercalating low molecular weight hindered phenolic antioxidants into the interlayer gaps of LDHs. In our works, a series of antioxidant intercalated LDHs with excellent antioxidative and anti-migration performance were developed based on the adjustable multivariate structure and interlayer functional guest intercalation assembly characteristics of LDHs. Particularly, breakthroughs in the one step synthesis of ultrathin antioxidant intercalated LDHs (L-LDHs), solvent blending, and other key technologies were achieved, realizing the precise preparation of a series of 1 ~ 10 layers ultrathin antioxidant intercalated LDHs and corresponding L-LDHs/PP composites. On this basis, a “fence” structure antioxidant intercalated LDHs with a small layer spacing at sheet edges was created to further inhibit the migration behavior of interlayer antioxidants. Besides, an efficient synthesis and organic-modification coupling strategy was developed to produce highly dispersed ultrathin antioxidant intercalated LDHs with low washing water consumption[2].

[1] Z. Li, C. Zhang, Y. Jiang, Y. Bai, M. Xu, K. Xu, D. Gao, F. Leroux, Y. Feng, Antimigration Polypropylene Antioxidants: A Review, Ind. Eng. Chem. Res. 63(4) (2024) 1713-1728.

[2] Z. Li, M. Zhao, R. Tian, Y. Shi, W. Tian, Y. Bai, M. Xu, K. Xu, D. Gao, Y. Feng, An efficient synthesis and organic-modification coupling strategy to produce highly dispersed ultrathin antioxidant intercalated layered double hydroxides for enhancing performance of polypropylene composites, Chem. Eng. J. 483 (2024) 149247-149256.