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Surface-Treated Mica in Polycarbonate Composites

Introduction

Mica is widely used as a functional filler in engineering thermoplastics due to its plate-like morphology, thermal stability, and reinforcement capability. However, unmodified mica often shows limited compatibility with polymer matrices, leading to poor dispersion and weak interfacial bonding. To address these limitations, chemical surface modification using silane coupling agents is commonly applied.

Surface Modification of Mica

In this study, the mica surface was chemically modified using:

- Vinyltrimethoxy silane
- 3-Aminopropyltriethoxy silane

These silane coupling agents are designed to react with hydroxyl groups on the mica surface while providing functional groups that interact more effectively with the polymer matrix.

Silanes are the most widely used coupling agents for filler surface treatment because they enable controlled modification of both:

- Surface chemistry, and
- Filler–polymer interfacial interactions

Effect on Dispersion and Morphology

Scanning Electron Microscopy (SEM) analysis showed that surface-treated mica dispersed more uniformly within the polycarbonate (PC) matrix compared to unmodified mica. The treated particles exhibited reduced agglomeration and improved distribution, indicating enhanced compatibility between mica and the polymer.

Improved dispersion is a direct result of reduced surface energy and better wettability of the treated mica particles.

Interfacial Interaction and Wettability

Surface treatment altered both the interface quality and the strength of interaction between mica and polycarbonate. Treated mica displayed:

- Better wettability by the polymer melt
- Stronger interfacial adhesion
- Reduced interfacial voids

These effects are attributed to chemical bonding or strong secondary interactions introduced by the silane functional groups.

Mechanical Property Enhancement

Polycarbonate composites filled with surface-treated mica showed:

- Improved tensile strength
- Increased modulus

The enhancement in mechanical properties is associated with improved stress transfer from the polymer matrix to the filler, enabled by stronger interfacial bonding and more uniform filler dispersion.

Thermal and Rheological Behavior

Thermal and rheological properties of the composites were evaluated using:

- Thermogravimetric Analysis (TGA)
- Differential Scanning Calorimetry (DSC)
- Rheological measurements

The results indicated that surface-treated mica influenced the thermal stability and melt behavior of the composites, consistent with improved filler–matrix interaction and more efficient load transfer under thermal and mechanical stress.

Conclusion

Chemical surface modification of mica using silane coupling agents significantly improves its performance in polycarbonate composites. Surface-treated mica exhibits better dispersion, enhanced interfacial adhesion, and improved mechanical properties compared to unmodified mica. By tailoring the surface chemistry, both the interface quality and interaction strength can be optimized, making silane-treated mica a more effective functional filler for engineering thermoplastic applications.