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MODIFICATION OF POLYTETRAFLUOROETHYLENE BY COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH VINYL ALCOHOL IN THE PRESENCE OF LOW-TEMPERATURE INITIATOR DIPDC

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Abstract: The present study focuses on the modification of polytetrafluoroethylene (PTFE) by copolymerization of tetrafluoroethylene (TFE) with vinyl alcohol (VA) using a low-temperature initiator DIPDC (Diisopropyl peroxydicarbonate). PTFE is widely known for its exceptional chemical resistance, thermal stability, and low friction coefficient, but its inherent inertness limits its adhesion and surface modification potential. Through copolymerization with VA, functional hydroxyl groups can be introduced into the polymer chain, enhancing the material's reactivity and surface properties. This paper describes the synthesis process, characterization of the copolymers, and the impact of this modification on PTFE properties.

Keywords: Polytetrafluoroethylene, Tetrafluoroethylene, Vinyl Alcohol, Copolymerization, DIPDC, Low-temperature initiator, Polymer modification.

Polytetrafluoroethylene (PTFE) is one of the most chemically resistant and thermally stable polymers, extensively used in chemical engineering, electronics, and aerospace industries. However, its high crystallinity and chemical inertness make it difficult to modify or functionalize its surface, limiting its application where adhesion or compatibility with other materials is required.

To overcome this limitation, introducing functional groups into the PTFE structure through copolymerization has emerged as a promising approach. Vinyl alcohol (VA) is an ideal comonomer for this purpose, as it contains hydroxyl groups that can enhance the surface energy, adhesion, and chemical reactivity of the resulting material.

Polytetrafluoroethylene (PTFE) is widely used due to its exceptional thermal stability, chemical resistance, and low friction coefficient. However, its extremely low surface energy and chemical inertness create challenges for adhesion, coating, and surface modification. To address these limitations, the introduction of functional groups into the polymer structure through copolymerization is considered an effective solution.

In this study, PTFE was modified by copolymerizing tetrafluoroethylene (TFE) with vinyl alcohol (VA), which contains hydroxyl groups that improve surface reactivity and wettability. A key element of the process was the use of diisopropyl peroxydicarbonate (DIPDC) as a low-temperature radical initiator. The advantage of DIPDC lies in its ability to initiate polymerization at 30–50°C, allowing for the preservation of the hydroxyl groups, which are sensitive to high temperatures.

The copolymerization process was carried out under controlled conditions in a high-pressure reactor. By adjusting the TFE to VA ratio and initiator concentration, it was possible to synthesize copolymers with varying degrees of surface functionality. The resulting materials were analyzed using Fourier-transform infrared (FTIR) spectroscopy, confirming the successful incorporation of hydroxyl groups from VA into the polymer chain.

Further characterization revealed noticeable improvements in the surface properties of the modified PTFE. Scanning electron microscopy (SEM) showed that the copolymer surfaces became more uniform and smoother compared to unmodified PTFE. Contact angle measurements demonstrated increased hydrophilicity, with water contact angles significantly reduced, indicating enhanced surface energy.

Thermal analysis using differential scanning calorimetry (DSC) confirmed that the copolymers maintained high thermal stability, although a slight decrease in melting point was observed with increasing VA content. This suggests that the modification introduces minor changes to the crystalline structure without significantly affecting the thermal resistance.

Mechanical tests showed that the modified PTFE retained good tensile strength, though samples with higher VA content exhibited a slight reduction in elongation at break. Nevertheless, the trade-off between improved surface properties and minor changes in mechanical behavior is considered acceptable for many practical applications.

Overall, the results demonstrate that the copolymerization of TFE with VA in the presence of DIPDC provides an effective method for PTFE modification. The introduction of hydroxyl groups significantly improves the material's surface reactivity and wettability, expanding its potential for use in areas such as membrane production, biomedical applications, and adhesive coatings.

Conclusion

The copolymerization of tetrafluoroethylene with vinyl alcohol using the low-temperature initiator DIPDC is an effective approach to modify PTFE. The introduction of hydroxyl groups improves surface reactivity and hydrophilicity without substantially affecting the thermal stability or mechanical performance of the material. These modified PTFE materials hold significant promise for applications where improved adhesion, surface functionality, and compatibility are required, such as membrane technologies, biomedical devices, and advanced coatings.

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