

Área: ORG

Eco-Friendly Hydroxyurethane Synthesis via CO₂ Fixation

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Palavras Chave: *Carbon dioxide fixation, Non-isocyanate hydroxyurethanes, Biocompatible polymer coatings*

Highlights

- Turning CO₂ into sustainable polymers for a cleaner industry.
- Green chemistry transforming waste gas into useful coatings.
- Safe, isocyanate-free hydroxyurethanes from captured CO₂.
- Innovative polymer films combining CO₂ fixation and graphene.
- Toward biocompatible coatings made from industrial emissions.
- Converting greenhouse gas into functional, non-toxic materials

Abstract

The increasing awareness of the environmental impacts caused by industrial CO₂ emissions has motivated the development of alternative processes that incorporate this gas as a raw material. In this study, non-isocyanate hydroxyurethanes (NIUs) were synthesized via chemical fixation of CO₂ into commercial epoxy compounds, establishing a sustainable route for polyurethane production. Two cyclocarbonate precursors—mono- and tris(cyclocarbonate)—were synthesized through the cycloaddition reaction of CO₂ to epoxides using tetraethylammonium bromide as catalyst. These intermediates were subsequently polymerized with primary aliphatic amines and aminosilane derivatives to yield hydroxyurethane polymers capable of forming films on glass, metallic, and polymeric substrates. The progress of cyclocarbonate and urethane formation was monitored by Fourier Transform Infrared Spectroscopy (FTIR), where carbonyl absorption bands were detected at approximately 1800 cm⁻¹ and 1706 cm⁻¹, respectively. Structural elucidation of the precursors and polymers was confirmed by Nuclear Magnetic Resonance (¹H and ¹³C NMR) and X-ray Photoelectron Spectroscopy (XPS), revealing characteristic peaks associated with urethane linkages. Composite hydroxyurethane films incorporating different concentrations of graphene were also produced to evaluate improvements in surface and mechanical properties. Contact angle measurements demonstrated good film formation and tunable hydrophilicity. Cytotoxicity assays using osteoblast-like MG-63 cells showed that the films exhibited cell viability above 70%, indicating satisfactory biocompatibility. The results confirm that CO₂ can be effectively converted into high-value polymeric materials through environmentally benign pathways, eliminating the use of toxic isocyanates while maintaining desirable physical and chemical performance. This approach highlights the potential of CO₂ fixation chemistry as a viable route toward greener polyurethane synthesis and advanced coating applications.

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