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FTIR Spectroscopy as a Tool for Microplastic Characterization

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Highlights

FTIR Spectroscopy as a Tool for Microplastic Characterization
Identification of PEAD, PEBD, PP, PA and PVC using FTIR.
Early spectral changes indicate oxidation onset.
Technique enables accurate polymer differentiation.

Resumo/Abstract

Fourier-transform infrared spectroscopy (FTIR) is widely recognized as an effective technique for the identification of microplastics in environmental studies due to its molecular selectivity, reproducibility, and non-destructive nature (JUNG et al., 2018). In this study, five polymers frequently found in plastic residues were characterized: low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polyamide (PA), and polyvinyl chloride (PVC). These polymers were chosen because they represent the majority of plastic waste reported in monitoring programs across aquatic, terrestrial, and atmospheric environments.

Analyses were conducted using a BRUKER spectrophotometer (Vertex 70). Samples were prepared in KBr pellets at a proportion of 100 mg of KBr to 1 mg of material. Spectra were acquired between 4000 and 400 cm^{-1}, using 4 cm^{-1} resolution and 32 scans to ensure appropriate signal-to-noise ratio. The resulting spectra were compared to the CAS Scifinder spectral database to enable accurate identification. LDPE and HDPE were distinguished based on C–H stretching and bending vibrations, PP exhibited methyl-related absorptions, PA showed N–H and amide bands, and PVC was identified by C–Cl absorptions.

A comparative evaluation was also carried out using samples exposed to artificial UV radiation for 200 hours to detect potential early chemical changes. Minor spectral alterations were observed in the carbonyl region (1600–1750 cm^{-1}), mainly in PP, PA, PVC, and LDPE, consistent with initial oxidation processes described in the literature (TANG et al., 2019). HDPE presented minimal variation, indicating greater resistance at early exposure stages.

The results demonstrate the effectiveness of FTIR in differentiating polymers with similar structures and in detecting early signals of chemical modification. The technique proves to be essential for environmental monitoring, polymer identification, and the development of standardized analytical approaches in microplastic research.

JUNG, M. R. et al. Validation of ATR FT-IR to identify polymers in marine plastic debris. *Marine Pollution Bulletin*, v. 127, p. 704-716, 2018. Disponível em: https://doi.org/10.1016/j.marpolbul.2017.12.061.

TANG, S. et al. Weathering behavior of polyethylene under UV exposure. *Environmental Science & Technology*, 2019. Disponível em: https://doi.org/10.1021/acs.est.9b02874

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