

Scientific report on the implementation of the project
PN-III-P2-2.1-PED2019-3970 (contract no. 357PED/2020) entitled
“Mitigation of Risk Factors for Public Health, Represented by Bio-Chemical Contaminants in Food and Pharma Packaging from Recycled Sources by A New Methodology Based on Spectral Analysis in Thz Domain – THzPET”, Phase 3-2022

Regarding plastic pollution research, Terahertz (THz) spectroscopy is insufficiently studied, but on the other hand, Fourier transform infrared (FTIR) spectroscopy has been extensively used in this important field, since has the advantage of great simplicity, rapidity and inexpensive, being widely employed in the fingerprint identification of molecular composition and structure.

In the present phase, we have used ATR-FTIR spectroscopy as a sensitive and effective assay for the identification of the deoxyribonucleic acid (DNA) isolated from experimental animals and collagen, used as biochemical contaminants.

Composite materials based mainly on recycled polyethylene terephthalate (rPET) and also high density polyethylene (HDPE), polypropylene (PP), and different amounts of aluminum and iron nano-powders obtained using an injection-molding machine have been used as contaminants substrate.

The contamination was performed using quantified nucleic acid solution or collagen solutions added in droplets on the clean, decontaminated PET samples, dried and kept in protective environment until the analysis. ATR-IR (using FT-IT Nicolet Summit Pro spectrometer equipped with Everest ATR accessory) spectroscopy has been used to analyze the bare composite materials substrate and the contaminated samples.

DNA identification on rPET composites

The peaks from Figure 1 highlighted the presence of DNA specific peaks on the contaminated support (3337 cm^{-1} , 1627 cm^{-1}), along with modifications and/or overlapping of the composite materials existing peaks.

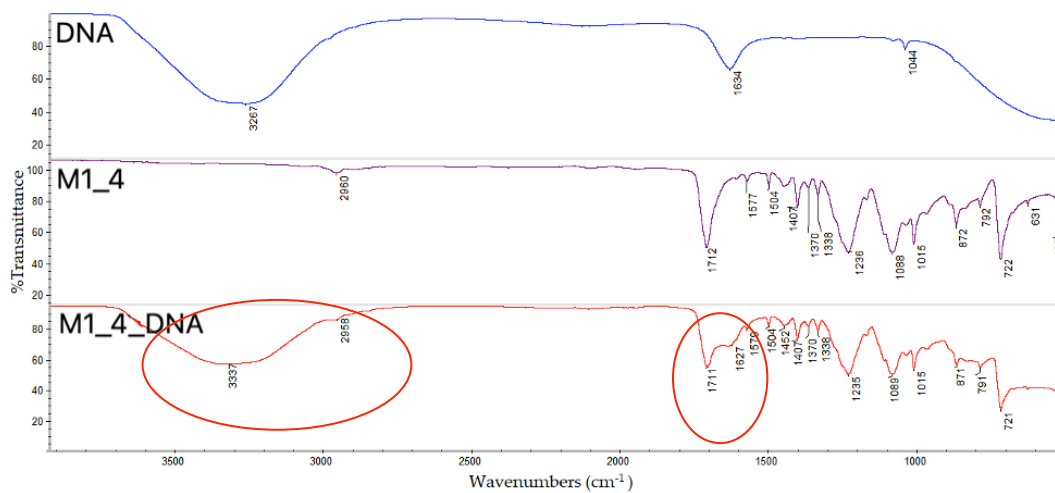


Figure 1. ATR-F TIR spectra of DNA, bare and DNA contaminated materials

Furthermore, the presence of DNA on the substrate surface has been highlighted using the ethidium bromide fluorescence enhancement on binding to DNA. For this experiment, 0.5 $\mu\text{g/mL}$ ethidium bromide has been added to each contaminated material after 2 h of incubation and analysed using Olympus CX41 Phase Contrast Polarized Light Microscope and UVP GelSolo Transilluminator, Analytik Jena AG, Germany (Figure 3), the appearance of fluorescence and emitted contrast on the contaminated supports demonstrate the presence of DNA.

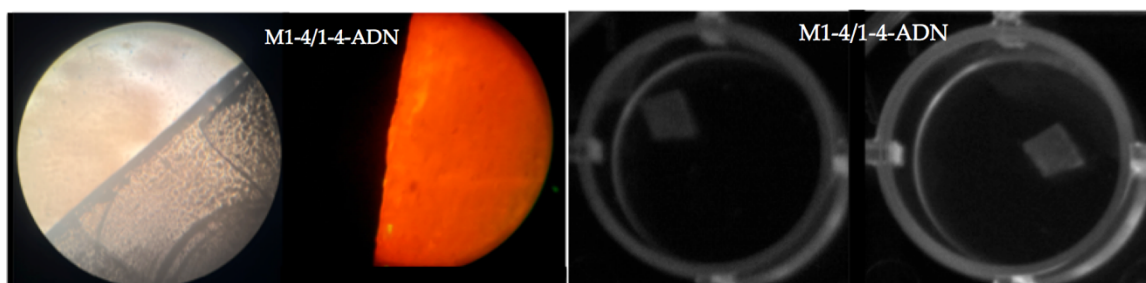


Figure 2. Images of bare vs. DNA contaminated materials (left) and UV images of bare vs. DNA contaminated materials (right)

Collagen identification on rPET composites

The peaks from Figure 3 highlighted the presence of collagen specific peak on the contaminated support (3328 cm^{-1}), along with modifications and/or overlapping of the composite materials existing peaks.

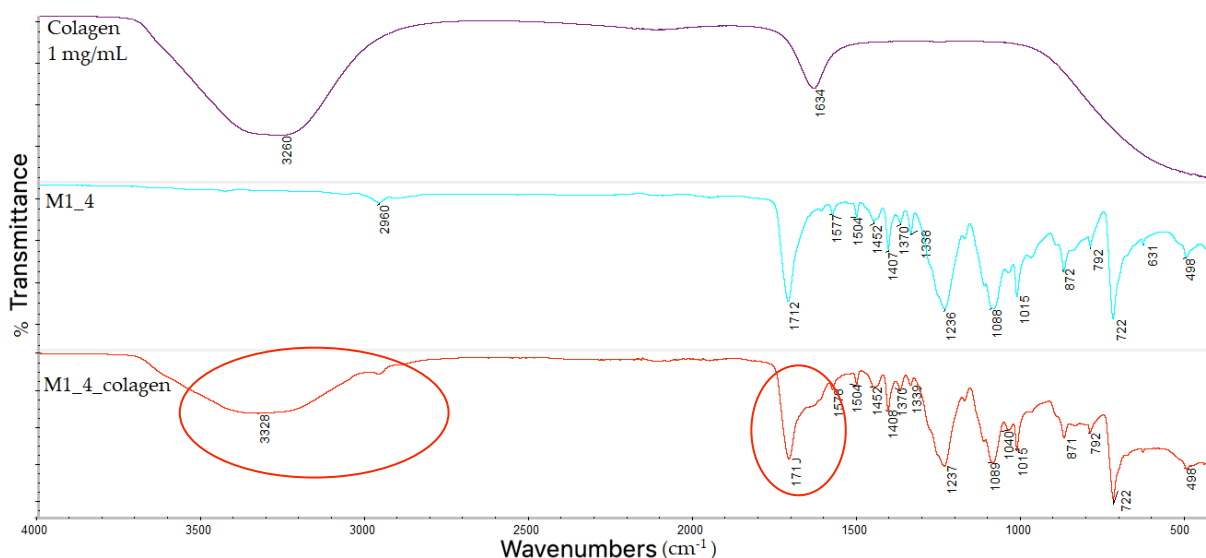


Figure 3. ATR-F TIR spectra of collagen, bare and collagen contaminated materials

Conclusions

To the best of our knowledge, the evaluation of PET packaging contamination with DNA species or collagen by FTIR has not been reported previously. This project demonstrated that

FTIR spectroscopy could provide a rapid, sensitive, and reliable approach for bio-chemical contaminants screening on composite materials based on recycled PET.

The deliverables associated the objective of phase 3:

- One ISI article accepted for publication: *Use of Fourier Transform Infrared Spectroscopy for DNA Identification on Recycled PET Composite Substrate*, authors: Gianina Dodi, Diana Popescu, Florina-Daniela Cojocaru, Mihaela Aradoaei, Cristian Romeo Ciobanu, Cosmin Teodor Mihai, journal: Applied Sciences, section: Materials Science and Engineering, April 2022.
- One article published in the extenso volume of *National Bioengineering Conference for Students and Young Researchers – 24th Edition*, Iași, Romania, 14-17 April 2022. (BENG 2022), Title: *Identification of biochemical compounds on thermoplastic supports using the ATR-FTIR technique*, authors: Diana Popescu, Florina-Daniela Cojocaru, Cosmin Teodor Mihai, Gianina Dodi, Mihaela Aradoaei, Cristian Romeo Ciobanu.
- Two conferences: *BraMAT 2022 - 12th International Conference on Materials Science & Engineering*, Brașov, Romania 9-12 March 2022 (poster) and *National Bioengineering Conference for Students and Young Researchers – 24th Edition*, Iași, Romania, 14-17 April 2022 (poster).
- National patent application request A00210/19.04. 2022.
- Final workshop with the participation of industry, R&D and clinicians: *Advanced methods for screening the contamination of recycled plastics*, authors: Gianina Dodi, Florina Daniela Cojocaru, Diana Popescu, Cosmin Teodor Mihai, Mihaela Arădoaei, Romeo Cristian Ciobanu.
- Informative brochures with the support of the Chamber of Commerce: *Informative brochure about the contamination of recycled plastics and analysis methods*, Florina Daniela Cojocaru, Gianina Dodi, Diana Popescu, Cosmin Teodor Mihai, Mihaela Arădoaei, Romeo Cristian Ciobanu.