Re-using food packaging and ocean waste plastic as additive modifier in asphalt materials

Gledson MESQUITA, Gabriele TEBALDI, Cédric SAUZÉAT, Elena ROMEO, Salvatore MANGIAFICO

LTDS Tribologie et Dynamique des Systèmes UMR 5513

Membre de INSTITUT CARNOT Ingénierie@Lyon

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UNIVERSITÀ DI PARMA — UNIVERSITÉ DE LYON — ENTPE

CONTEXT

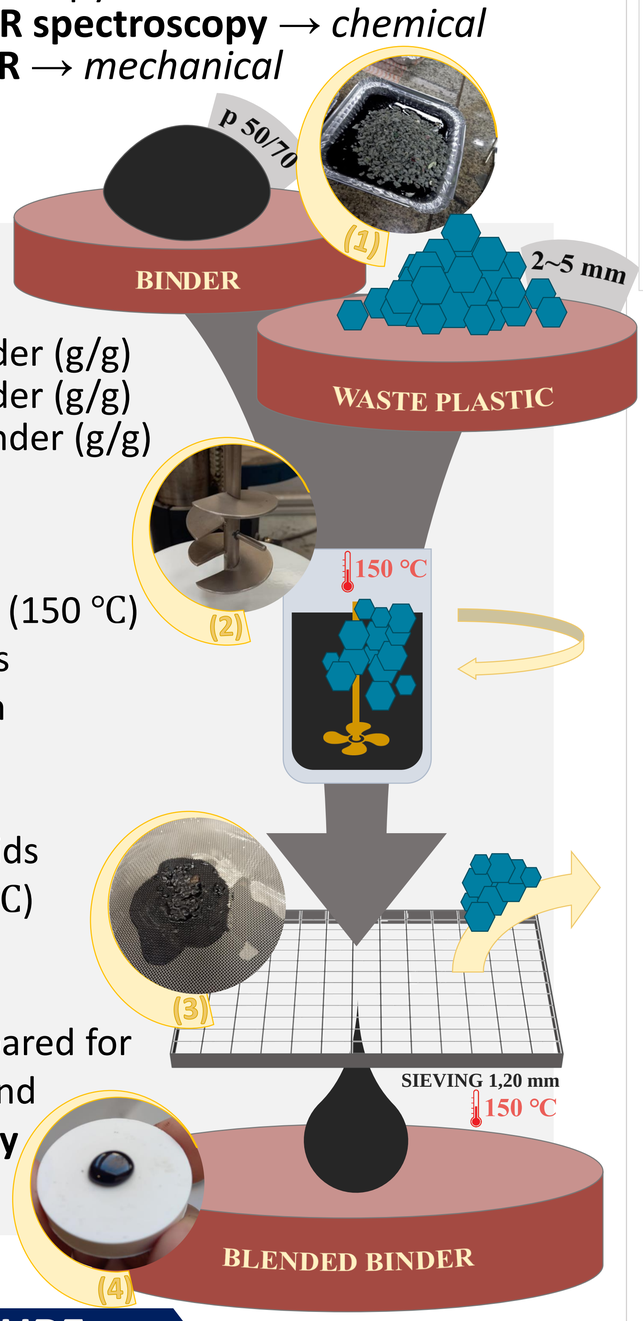
- Enhance the **circularity** of **waste plastic** not recyclable
- Re-use plastic from food packaging in pavements as an alternative material
- Collaboration **University of Parma** and **ENTPE**

OBJECTIVES

- Characterize plastic from food packaging
- Determine effects of plastic on bitumen behavior (chemical and mechanical)

MATERIALS PREPARATION

- **Materials**: **waste plastic** component sourced from food packaging and **asphalt binder** 50/70
- **Characterization**:
  - Plastic: calorimetry analysis (**TGA** and **DSC**) and **FTIR** spectroscopy → *chemical*
  - Binders: **FTIR spectroscopy** → *chemical*
    DSR → *mechanical*
- **Samples:**



(1) Mix
Plastic + binder
- 0% plastic/binder (g/g)
- 5% plastic/binder (g/g)
- 20% plastic/binder (g/g)

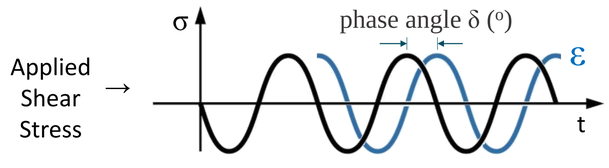
(2) Blending
High Shear Mixer (150 °C)
- 15~60 minutes
- 200~1000 rpm

(3) Sieving
Separation of solids
Φ1.20 mm (150 °C)

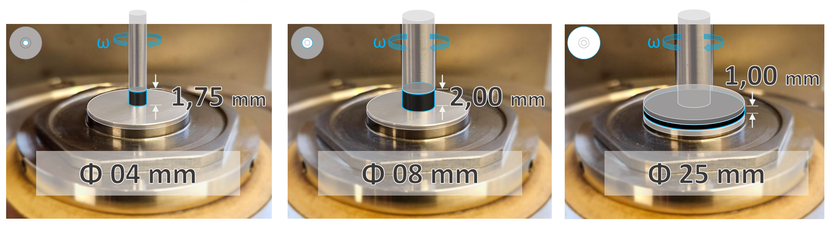
(4) Samples
Samples are prepared for **DSR procedure** and **FTIR spectroscopy**

DSR PROCEDURE

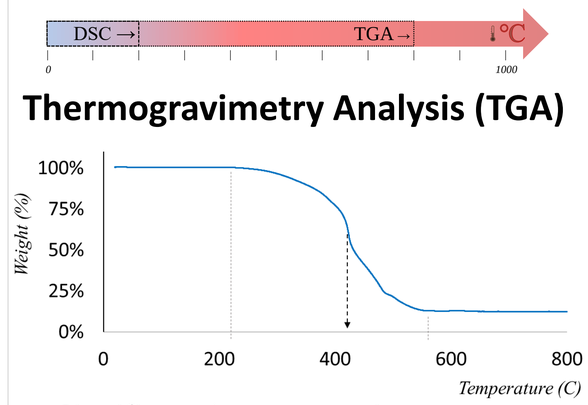
Procedure performed in the **Dynamic Shear Rheometer** applying a cyclic load



→10 temperatures: - 20 → 70°C ;
→7 frequencies: 0,01 → 10 Hz;
→3 different geometries



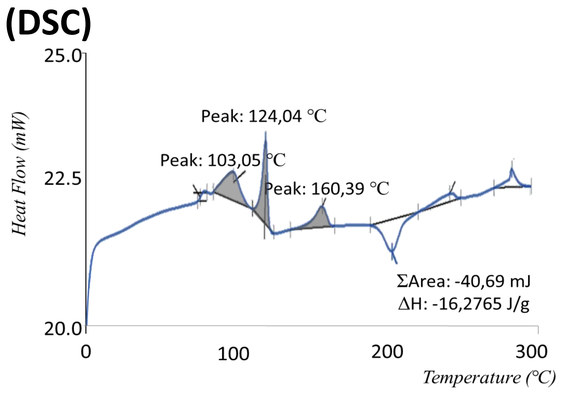
CHEMICAL ANALYSIS



Thermogravimetry Analysis (TGA)

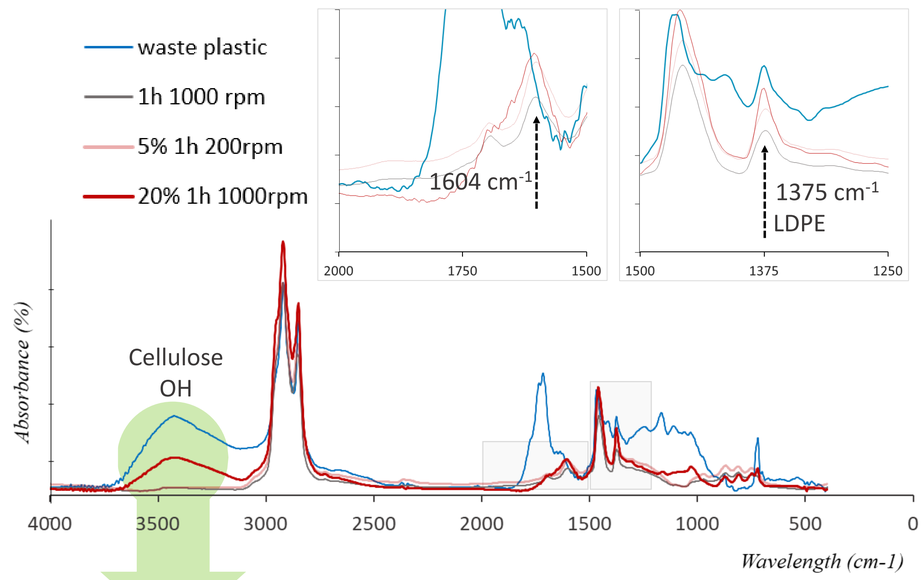
- Significant heterogeneity

Differential Scanning Calorimetry (DSC)



- Two processes within the range of 100 to 150 °C.
- Some components might melt around these temperatures.

Fourier-transform infrared spectroscopy (FTIR)

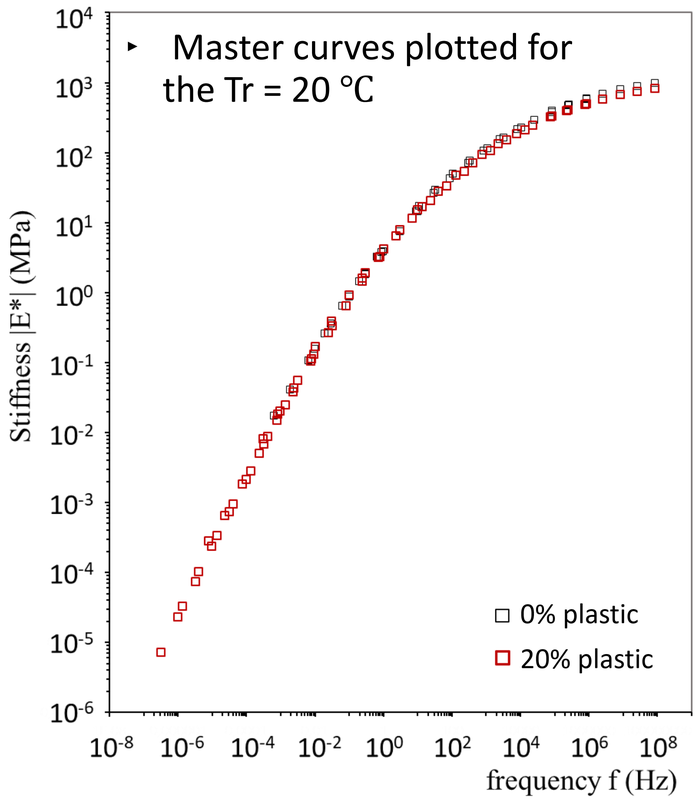


- Functional groups of **cellulose** (3446 cm^{-1})
- Residues found in samples mixed with 20% of plastic
- The **waste plastic** is a composite of various polymers, notably **HDPE** and **LDPE**
- Low mobilization from the polymers to the asphalt binder

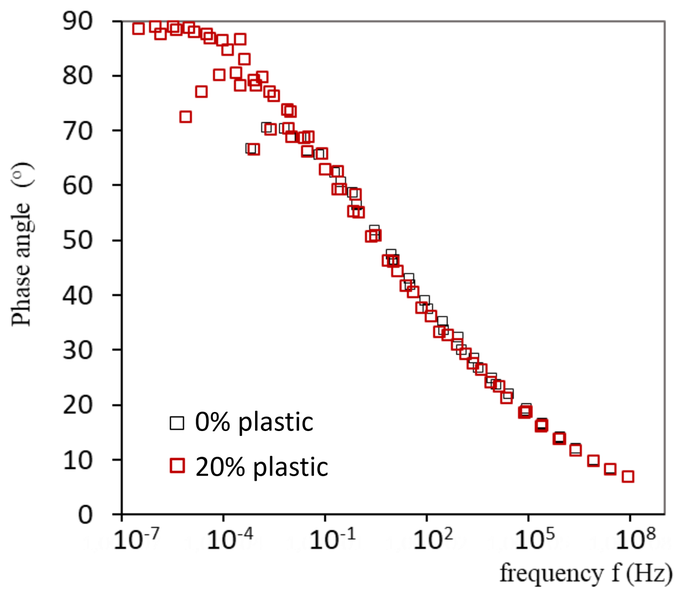
MECHANICAL ANALYSIS

Dynamic Shear Rheometer (DSR)

20% of plastic vs. 0% of plastic (30 min and 1000 rpm blending)



- Effect of possible ageing
- After interaction with plastic, no difference in mechanical behavior of binder



CONCLUSIONS

- Plastic composition
  - Polymers (HDPE, LDPE, PET) and other residues (Cellulose, Aluminum)
- Interaction
  - Involves physical processes rather than chemical modifications
    - Little difference was observed between the binder blended with **20% plastic** and the binder blended without plastic (0%)
    - A procedure where the plastic source is treated like an alternative aggregate (**DRY METHOD**) is recommended for inserting plastic in the Mixes in data

Gledson S. MESQUITA Júnior
gledson.mesquita@entpe.fr

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