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Pb isotopic ratio determination in recycled plastic samples by MC-ICP-MS: An Analytical feasibility

FABIEN CHAINET[1], JULIEN P.G. BARRE[2], NATHALIE TEXIER[1], **LAURANE BOURDELOUX**[2] AND SYLVAIN BÉRAIL[3]

[1]IFP Energies Nouvelles
[2]Advanced Isotopic Analysis
[3]ADVANCED ISOTOPIC ANALYSIS (AiA)

Presenting Author: Laurane.bourdeloux@ai-analysis.com

Plastic recycling is one of the main challenges of the energy transition. Plastics are widely used in many fields (automotive, packaging, and housing) and generate a huge quantity of waste. As mechanical recycling is typically accompanied by degraded plastic properties, chemical recycling is needed to develop a circular economy, in which monomers and oligomers can be re-polymerized following purification and used in similar applications as the virgin polymer equivalent, which is produced from fossil fuels.

Inorganic elements for coloring and heat stabilization (oxides of Ti, Zn, Co, and Pb), flame retardant synergic species (Sb_2O_3) or other stabilizing purposes (organometallic compounds of Ba, Sn, and Zn) is usually used in the plastic industry [1]. During the plastic life cycle, from the formulation to the recycling process and possible fate in the environment, the isotopic signature of the elements can be modified and need to be determined to access to the evolution of inorganic elements during the life cycle of the plastic (recycling plastic content, purification, environment accumulation, ...).

The aim of this work is to develop a complete methodology to measure the isotopic ratios for plastic containing heavy elements using MC-ICP-MS. For the analytical feasibility, the study is only focused on the Pb isotopes determination. After a MAWD (microwave-assisted wet digestion) method to mineralize the sample, the purification step using ion exchange resin (AG1-X8) was optimized with a virgin PP spiked with a Pb isotopes standard (NIST 981, $^{208}Pb/^{204}Pb = 36.724 \pm 0.009$ [2]). Elution profile of Pb and interfering elements during the purification step were analyzed by ICP-QMS prior to MC-ICP-MS analysis. After this crucial optimization, a PE EC 680 certified at 11.3 mg/kg of Pb and one real PP waste sample containing Pb and coming from mechanical recycling were chosen to validate the developed methodology.

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