interzero®
zero waste solutions

Leading European **competence centre** for plastics recycling

All services of Interzero Plastics
Innovations at a glance

Research and development in the field of **plastics recycling**

The Interzero Plastics Innovations d.o.o. competence centre specialises in the research and development of recycled plastic materials and is a leading European innovator in the field of sustainable zero waste solutions. The centre's team of experts develops tailor-made, high-quality modified plastics from a variety of waste collection streams to achieve more sustainable products and production processes while helping companies reduce their carbon footprint and the use of primary raw materials.

To support businesses in completing a smooth transition to using recycled plastics in their production, the competence centre makes continuous progress in research and development to meet the specific plastics quality requirements and manufacturing needs of its customers. Thanks to the combination of multidisciplinary know-how and the unique development of customised sustainable zero-waste solutions, Interzero supports its customers across Europe with efficient recycling.

Accreditation

In 2020, Interzero Plastics Innovations d.o.o. was awarded international SIST EN ISO/IEC 17025:2017 accreditation by Slovenian Accreditation (SA) and the European co-operation for Accreditation (EA). With accreditation number LP-116 in the field of testing (SIST EN ISO/IEC 17025) compliant laboratory services support a broad range of research projects, quality control, developments, and problem-solving solutions, including failure analysis for advanced recycled and primary plastic materials and their products. Every year, the competence centre expands its service portfolio of methods beyond accreditation, while continuously proving its laboratory's competencies and excellence in the field of plastics recycling, development, and analysis.

Our **services** for **zero waste solutions**

The Interzero Plastics Innovations d.o.o competence centre provides a wide range of activities to help customers overcome the challenges encountered throughout plastics supply chains, including questions regarding safety, quality, recycling, processability, process development, degradability, regulatory compliance and performance. To meet the challenging demands of the plastics recycling market, the following services are offered:

- **Development** of new, tailor-made high-quality materials from post-consumer (PCR, lightweight packaging), post-consumer commercial (PCC) and post-industrial (PIR) waste sources as well as compounds with a virgin polymer matrix.
- Comprehensive **consulting services**, aimed at achieving sustainable plastic recycling processes in various business and end-user application areas.
- **Accredited material testing** and **analysis** according to internally developed methods.
- **Technical quality assessment** of recycled and primary plastics, monitoring the relevance and compliance of these materials with EU (e.g. REACH) and other international legislation.
- **Evaluation of the recyclability** according to Made for Recycling methodology.

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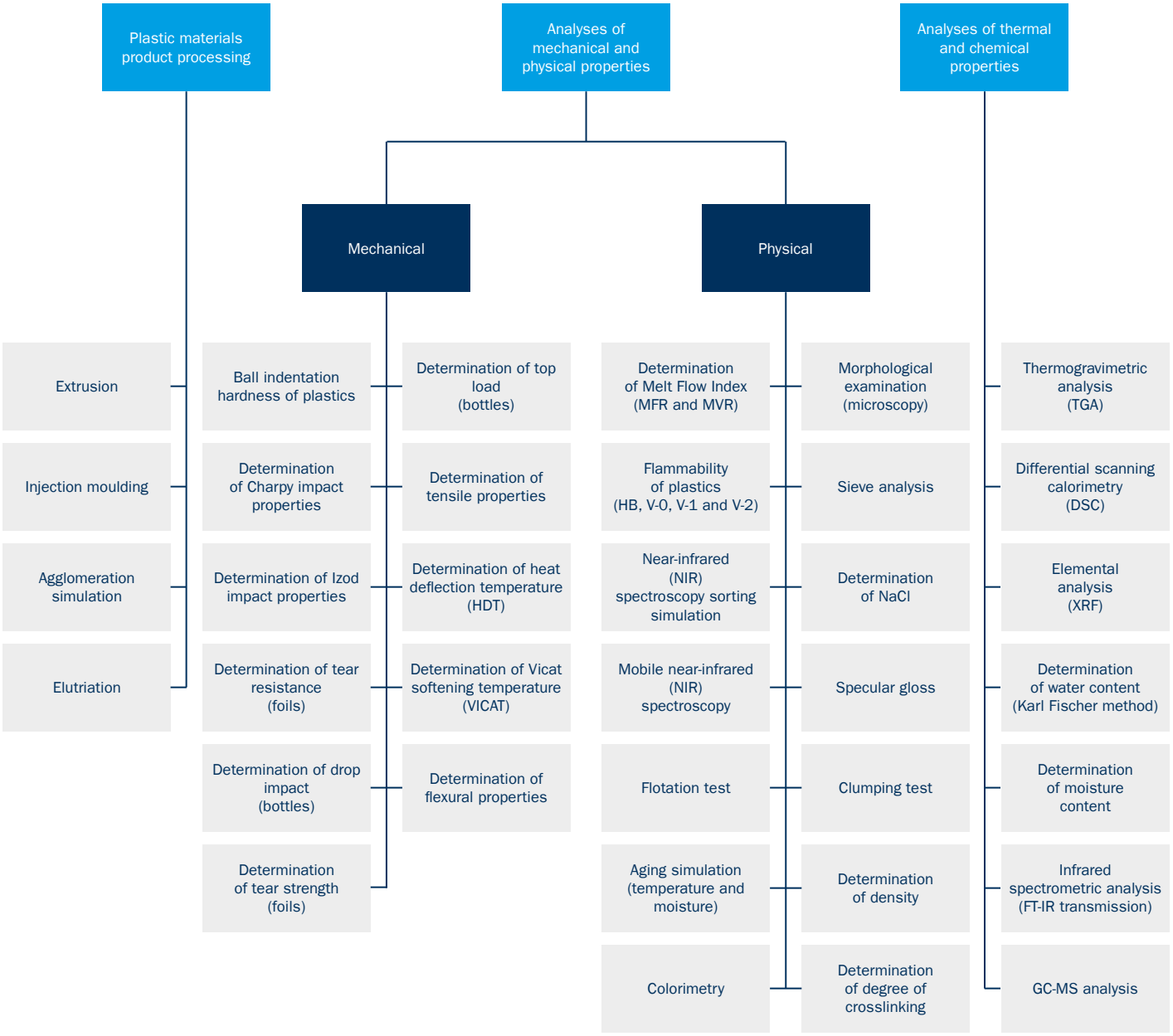
Broad spectrum of **analytical methods**



Within modern pilot plant facilities, **plastic materials processing** includes pre-treatment processes such as grinding, elutriation, washing, flotation, drying, agglomeration, single and/or multiple extrusion with compounding, and injection moulding. This can be conducted in various batch sizes, utilising plastics sourced from a variety of material streams.

EXTRUSION

Technical data:

- 3 main gravimetric feeders
- 2 side feeders
- Vacuum degassing system
- Pelletiser
- Measurement of pressure and temperature

- Operating range:
  - Max. temperature 400 °C
  - Throughput 10 – 90 kg/h

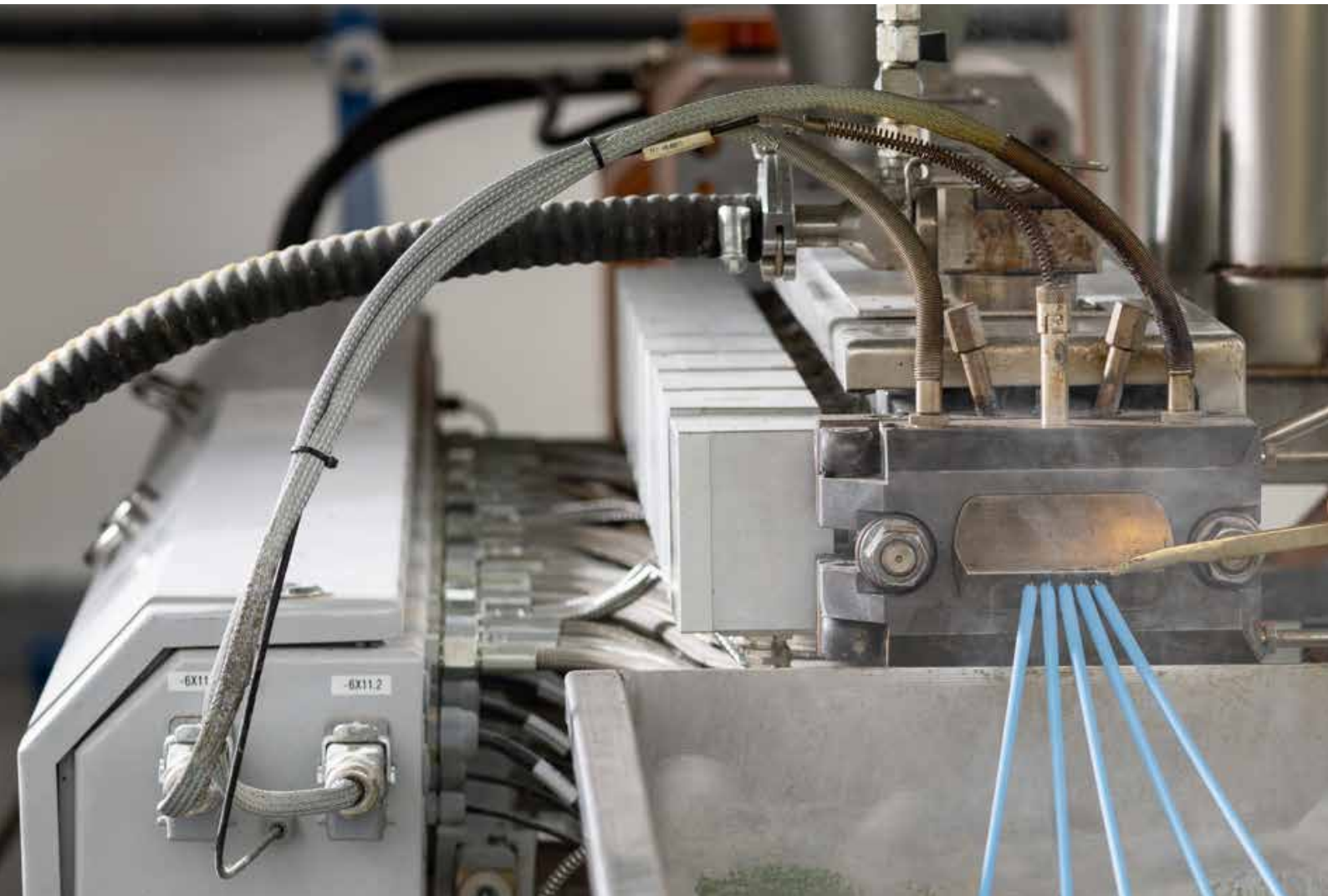
Featuring two side feeders and a gravimetric dosing system, the double screw extruder facilitates the processing of a wide spectrum of thermoplastics, from standard and technical primary raw or recycled plastics to highly filled compounds.

AGGLOMERATION SIMULATION

Technical data:

- Total volume: 100 l
- Rotating blade: 2 pcs
- Fixed blade: 6 pcs
- Rotating speed: 750 rpm
- Motor power: 30 kW
- Capacity (approx.): 80 – 100 kg/h
- Heating bearing cooling system: water-cooled

A material preparation process used to physically transform folis and flexible plastics into regrind that is suitable for feeding into the hopper of an extruder or for direct injection moulding.



ELUTRIATION

Technical data:

- Feed hopper: 10 l
- Feeder: max speed 50 Hz
- Air fan: max speed 50 Hz

The Elutriation is utilised for small-batch gravity separation of plastics, designed with specific weights within a vertical blast of air located directly behind the vibrating feeder.

INJECTION MOULDING

Technical data:

Clamping force 50 t

Different injection moulding tools
(ISO 294, ISO 3167) for:

- Tensile testing (ISO 527)
- Charpy, Izod tests (ISO 179, ISO 180)
- Flammability testing (UL94)
- Stepped colour plates
- Conditioning according to ISO 291

The injection moulding machine is used to manufacture plastic parts, primarily with the aim of realistically replicating production processes and utilising the resulting product for overall quality evaluation.

Physical and mechanical testing is a vital part of the development and production process for plastics. Performed with the end-application in mind, the various tests assess a wide range of mechanical properties such as tensile strength, material hardness, heat deflection and softening temperatures, burst, drop and top-load properties, tear strength and the plastic material's impact resistance. All these are used to assess the performance of plastics under various types of stress.

Mechanical analysis

DETERMINATION OF HARDNESS

Technical data:

- Ball indentation hardness
- Plastics and ebonite
- According to ISO 2039-1
- Test load: 49 N / 132 N / 358 N / 961 N

Material hardness is determined using the ball indentation method which assesses the material's resistance to permanent indentation.

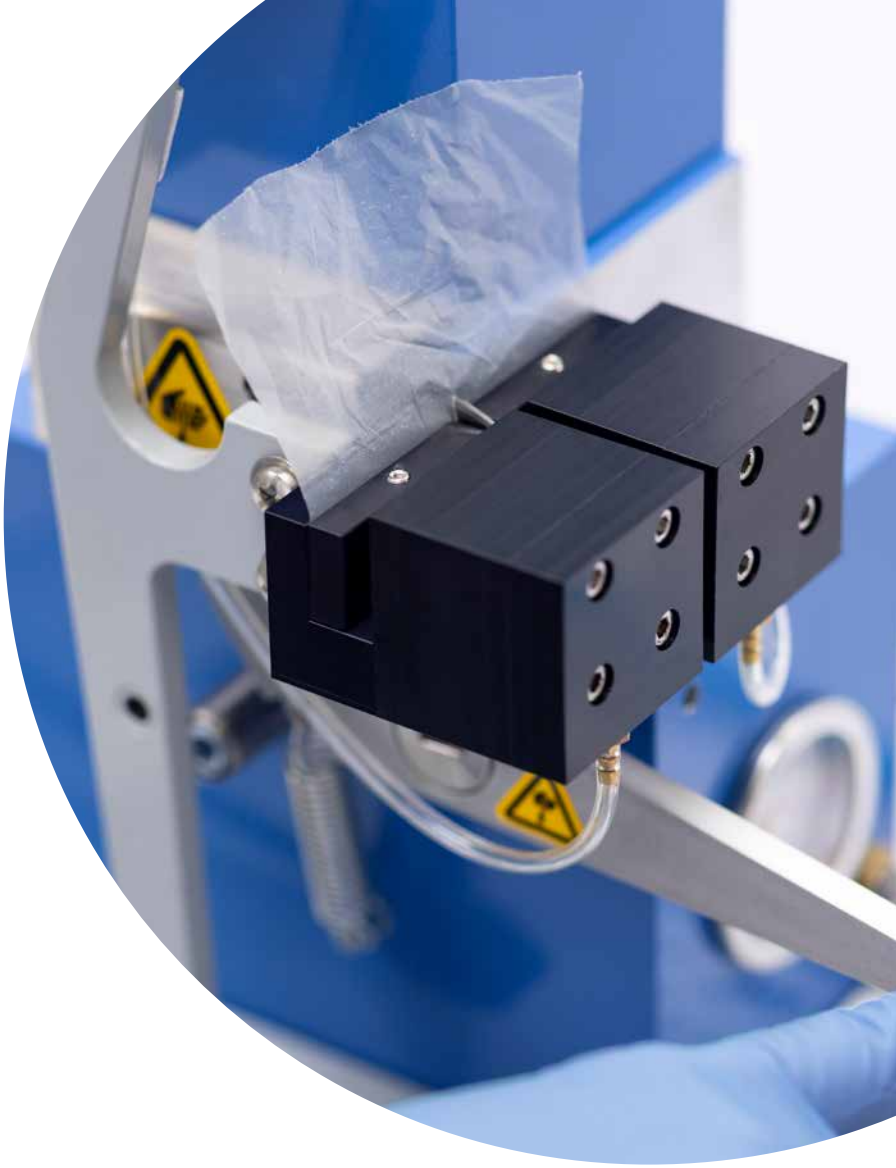
DETERMINATION OF IMPACT PROPERTIES

Technical data:

Impact test

- Charpy and Izod
- 23 °C and –30 °C
- With or without notch
- According to ISO 179 and ISO 180

Impact testing measures the energy absorbed by the material during fracture and provides information on its toughness. In the case of solid plastics, testing is typically performed by hitting the specimen with a hammer (Charpy or Izod impact tests). The test can be conducted on a sample with or without a notch, at 23 °C and –30 °C.



DETERMINATION OF IMPACT RESISTANCE BY THE FREE-FALLING DART METHOD (FOILS)

Technical data:

- Method A: used for materials whose impact resistance requires masses of about 0.05 – 2 kg to fracture them.
- Method B: used for materials whose impact resistance requires masses of about 0.3 – 2 kg to fracture them.
- According to ISO 7765-1

The free-falling dart method is used to evaluate the impact strength or toughness of a plastic film.

DETERMINATION OF TEAR RESISTANCE (FOILS)

Technical data:

Elmendorf method:
- For materials such as flexible PVC and polyolefin films
- According to ISO 6383-2

The Elmendorf tear test is used to measure the resistance of plastic films to tearing. It is conducted by measuring the force required to propagate a tear from a predefined distance with slit that is cut in a test specimen of thin flexible plastic sheeting or film, under specified loading conditions.

DETERMINATION OF DROP IMPACT (BOTTLES)

Technical data:

- Min drop height: 0.77 m
- Max drop height: 1.80 m
- Straight and Angular Drop test
- Procedure A, Static Drop Height Method
- Procedure B, Bruceton Staircase Method
- According to ASTM D2463

Drop impact is determined by measuring the resistance to deformation of a blow-moulded container.

DETERMINATION OF TOP LOAD (BOTTLES)

Technical data:

- Measurement range: 0 – 2500 N
- Speed: 0.1 – 1200 mm/min
- Crosshead travel: 500 mm
- According to ASTM D2659

To determine the top load, a downward compressive force is applied to a blow-moulded container and its resistance to deformation is measured.

DETERMINATION OF TENSILE PROPERTIES

Technical data:

Tensile test
- Young's modulus
- Tensile strength
- Elongation
- According to ISO 527

Tensile testing is used to determine how plastics perform under controlled tension assessing the Young's modulus, tensile strength and elongation of the material.

DETERMINATION OF HEAT DEFLECTION TEMPERATURE (HDT)

Technical data:

- Load:
  - Method A: 1.80 MPa
  - Method B: 0.45 MPa
  - Method C: 8.00 MPa
- Heating rate: 120 °C/h
- According to ISO 75-2

The heat deflection temperature (HDT) is determined by measuring the loss of stiffness within rising temperature and under a constant force performed.

DETERMINATION OF VICAT SOFTENING TEMPERATURE (VICAT)

Technical data:

- Load: 10 N or 50 N
- Heating rate: 50 °C or 120 °C/h
- According to ISO 306

The VICAT softening point determines the temperature at which a flat-ended needle penetrates the sample to a depth of 1 mm under a specified load and at a selected uniform temperature increase.

DETERMINATION OF FLEXURAL PROPERTIES

Technical data:

- Flexural modulus
- Flexural strength
- Flexural strain
- According to ISO 178

Flexural testing measures the force required to bend a beam under three-point loading conditions. To determine the flexural properties of a plastic, i.e. the ability of the material to resist deformation under load, a force is applied to the sample and the resulting deflection is measured. The flexural modulus gives an indication of a material's stiffness when flexed.

Physical analysis

MELT FLOW INDEX (MFR AND MVR)

Technical data:

- Melt mass flow rate (MFR)
- Melt volume flow rate (MVR)
- Temperature range: 50 – 400 °C
- Load: 0.325 – 21.6 kg
- According to ISO 1133

The rheological properties of the melt mass flow rate and melt volume flow rate are determined as the rate of extrusion of a thermoplastic through an orifice at a prescribed temperature and load.

FLAMMABILITY OF PLASTICS

Technical data:

- Flammability testing for plastics for parts in devices and appliances
- Methods: horizontal (HB) and vertical (V-0, V-1 and V-2)
- According to UL94

A self-extinguishing test for plastics is performed using two methods: horizontal (HB) and vertical (V-0, V-1 and V-2).

NEAR-INFRARED (NIR) SPECTROSCOPY SORTING SIMULATION

Technical data:

- Recognisable types of plastic: PE, PET, PP, PS, PVC and cellulose/cellulose. System can be taught other types or matching logic can be developed for other materials.
- Compressed air quality: ISO 8573-1 (class 3.4.4)
- Operating pressure: 5.5 bar
- IR measuring range: 760 – 2500 nm

The NIR scanner simulates the sorting process utilised at sorting plants, detecting and allocating various polymers into predefined streams.

MOBILE NEAR-INFRARED (NIR) SPECTROSCOPY

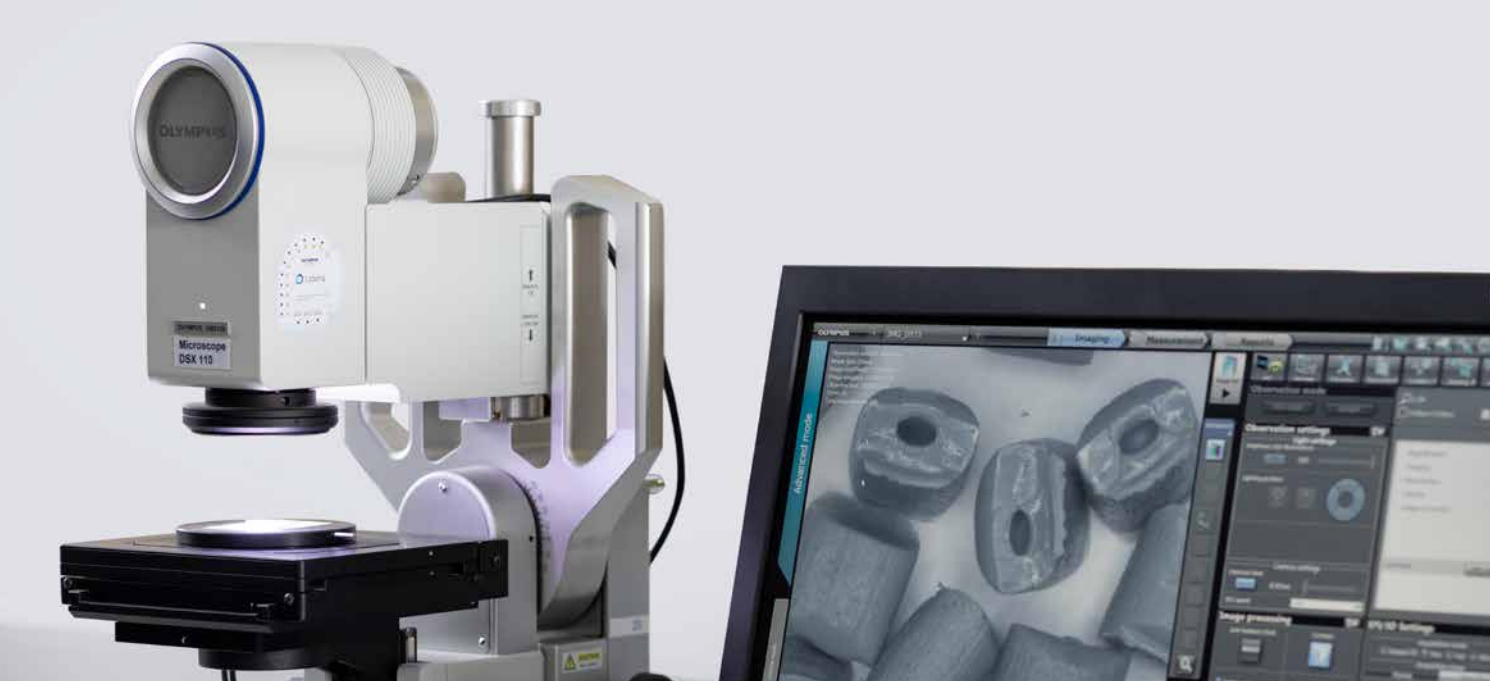
Technical data:

- Measurement principle: high-performance NIR spectrometer
- Identification of various types of plastics
- 6 tungsten halogen lamps
- Resolution: 1% of wavelength
- IR measuring range: 1450 – 2450 nm
- Detector: 256-pixel PbS line-array detector

NIR spectroscopy with a mobile NIR scanner is used for rapid, on-the-spot plastic type determination.

FLOTATION TEST

The flotation test simulates an industrial recycling line process using particle separation by density, as applied in sink/float tanks.



AGING SIMULATION (TEMPERATURE AND MOISTURE)

Technical data:

- Aging/conditioning chamber
- Temperature range:
  - Without humidity: –42 to 190 °C
  - With humidity: 10 to 95 °C
- Humidity: 10–98%

The aging/conditioning chamber is used for the controlled simulation of various environmental conditions and an evaluation of the aging process.

COLORIMETRY

Technical data:

- For solids, granulates, powders, pastes and liquids
- Reflectance and transmittance
- SCI (specular component included)
- SCE (specular component excluded)
- According to ISO 11664-4:2019

Colorimetry testing is used to determine the coordinates of the CIE 1976 L*a*b* colour space, including correlates of lightness, chroma and hue methods to calculate the Euclidean distances.

MORPHOLOGICAL EXAMINATION (MICROSCOPY)

Technical data:

- Optical zoom: 1 – 16x
- Digital zoom: 17 – 30x
- LED ring light illumination

Optical microscopy is used to determine the structural features of polymers, composites and products, providing insights relating to the performance of the material. The examination determines the orientation and distribution homogeneity of inorganic fillers, such as fibres, and surface irregularities caused by contaminates or moisture in the material.

SIEVE ANALYSIS

Technical data:

- Fritsch Analysette 3
- Measuring range: 500 µm to 10 mm
- Sieving time: 3 – 20 min (approx.)
- According to DIN 66165

Determination of the particle size distribution of materials with macroscopic particle sizes. The process involves several layers of sieves with different mesh grades.

DETERMINATION OF NATRIUM CHLORIDE (NaCl)

Technical data:

- Titration of chlorides with $AgNO_3$
- Analysis in a neutral or weakly alkaline medium
- K_2CrO_4 solution is used as an indicator

Sodium chloride (NaCl) salt levels are analysed via titration to determine the chloride ion concentration in a water sample.

SPECULAR GLOSS

Technical data:

- Specular gloss
- A 45-degree gloss angle is recommended for intermediate- and low-gloss films
- According to ASTM D2457

Specular gloss, the capacity of a polymer surface to reflect light in a given direction, is analysed to measure the shiny appearance of films and surfaces.

DENSITY

Technical data:

- Immersion method for void-free solids
- According to ISO 1183-1

The mass per unit volume of a material is determined using the immersion method as the ratio of the mass of a given volume of this material at 23 °C to the same volume of deionised water.

CLUMPING TEST

Technical data:

- According to APR PET-S-08

The clumping test detects low melting-point polymers or other sources of contamination in washed and elutriated PET flakes.

DEGREE OF CROSSLINKING (PE-X)

Technical data:

- For crosslinked polyethylene (PE-X) pipes and fittings
- Solvent: xylene
- According to ISO 10147

The degree of crosslinking in crosslinked polyethylene (PE-X) pipes and fittings is measured as the gel content after solvent extraction.

The **thermal analysis** of plastics aims to determine a material's suitability for its intended usage by providing information about its thermal properties and transitions. **Chemical analysis** utilises a wide range of methods to identify the fundamental chemical structural information of materials.

THERMOGRAVIMETRIC ANALYSIS (TGA)

Technical data:

- Max. temperature: 1100 °C
- Heating rate: 0.02 to 150 °C/min
- Measurement range: ≤5 g
- Resolution: 0.1 µg
- Atmosphere: air, nitrogen (N_2) and oxygen (O_2)
- According to ISO 11358

To determine the composition of an unknown sample, thermogravimetric analysis (TGA) provides a quantitative measurement of the mass change in materials associated with sample transition and thermal degradation as a function of the change in temperature in a controlled atmosphere.
Thermogravimetric analysis / infrared spectroscopy (TGA/FTIR) can be combined to provide a detailed FTIR analysis of the evolved gases produced through TGA.

DIFFERENTIAL SCANNING CALORIMETRY (DSC)

Technical data:

- Max. temperature: –100 to 700 °C
- Heating rate: 0.02 to 300 °C/min
- Atmosphere: air, nitrogen (N_2) and oxygen (O_2)
- According to ISO 11357

Differential scanning calorimetry (DSC) determines the energy absorbed or emitted by a material as it is heated or cooled. DSC generates data from the stages of deflection, glass transition, cold crystallisation and the melting of the crystalline fraction, which can be used to evaluate the plastic's purity, quality, material compatibility and effects of additives.

ELEMENTAL ANALYSIS (XRF)

Technical data:

- 50 W Pd end-window X-ray tube
- HOPG crystal (a special form of graphite)
- X-rays excite the atoms of the sample to emit radiation. This radiation is measured by a semiconductor detector.
- Measurement of the following elements: Cl, Cr, Zn, Br, Cg, Sb, Hd and Pb.
- According to DIN 51418-2

X-ray fluorescence (XRF) analysis is conducted to determine the elemental composition of materials, the chemical composition and the concentration of individual elements. Each of the elements present in a sample produces characteristic fluorescence radiation – an identifiable 'fingerprint'.

DETERMINATION OF WATER CONTENT

Technical data:

- Karl Fischer method, according to ISO 760
- Method B2 according to ISO 15512

Karl Fischer titration is a method for determining the water content of a gaseous, liquid or solid material at concentrations as low as a few ppm.

INFRARED SPECTROMETRIC ANALYSIS (FTIR)

Technical data:

- 'Fingerprint' technique
- Spectral library
- ATR crystal and TGA-IR module
- Solids, liquids and powders
- According to DIN 51451

Infrared spectrometric analysis (FTIR) can be applied to solids, liquids and powders as a reliable analytical tool for identifying polymers and assessing the quality of plastics.

MOISTURE CONTENT

Technical data:

- Loss of mass with drying method
- Applies only to materials with a moisture content of not more than 10%.
- According to ASTM D6980

The drying loss method is used to determine a material's surface moisture content.

GC-MS ANALYSIS

Technical data:

GC-MS instrument featuring:

- Constant pressure, constant column flow and constant linear velocity flow control modes
- Mass analyser and detector, mass range m/z 1.5 to 1090
- High-speed scan rate of 20,000 amu/s
- Pump speed 190 l/s and 170 l/s (He), turbomolecular pump differential
- Extraction system
- Column flow rate up to 15 ml/min

Gas Chromatography Mass Spectrometry (GC-MS) is a powerful tool for monitoring contaminants in air, water and soil. It utilises the separation of gaseous ions emitted by the analyte according to differences in their mass and charge to facilitate the qualitative and quantitative identification of a substance's chemical composition.

Would you like to learn more about the developments and analyses of Interzero Plastics Innovations? Get in touch. We will happily advise and guide you on the journey to an efficient circular economy and a more sustainable future.

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