

Crystallinity & Density of Polyethylene

● Process Monitoring and Quality Control | Application #19 |

The crystallinity of polyethylene (PE) determines the stiffness, the impact and tensile strength, the permeability and the resistance of the material. Therefore, its measurement is of paramount importance regarding the specifications of a PE grade. Bruker's PE crystallinity application provides this information fast, with high precision and repeatability. Other commonly employed methods such as Differential Scanning Calorimetry (DSC) or density determination by displacement are significantly slower and require tedious sample preparation. The analysis can be carried out *at line* by untrained personnel requiring no dedicated lab environment.

The obtained crystallinity correlates to the density measured with:

- **ISO 1183 / ASTM D1505** (method by titration / displacement / pycnometer)
- **ASTM D792** (displacement method)
- **ASTM D4883** (ultrasound)

Features and Benefits

- QC of product specifications
- *At line* measurement
- Minimal sample preparation (pellets and powders are measured *as is*)
- 25 min. from taking the sample to validated result
- Daily check instrument validation

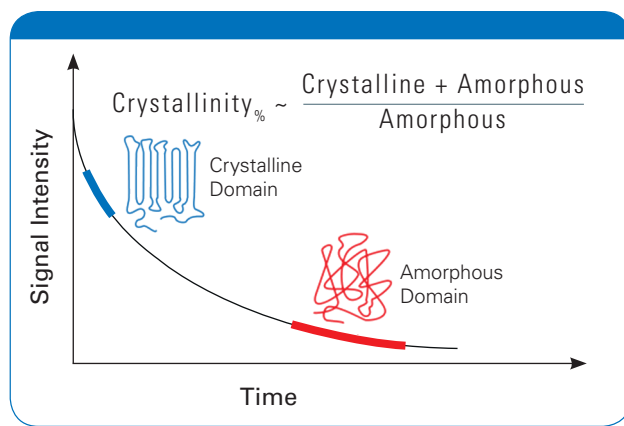
Applicable to all PEs

- UHMWPE – Ultra High Molecular Weight Polyethylene
- HDPE – High Density Polyethylene
- MDPE – Middle Density Polyethylene
- LDPE – Low Density Polyethylene
- LLDPE – Linear Low Density Polyethylene
- mLLDPE – Metallocene Linear Low Density Polyethylene
- PE copolymers

Application Method

The application Crystallinity of PE is based on the different relaxation times in the crystalline and amorphous domains of the polymer. Protons in crystalline or rigid domains return significantly faster to the equilibrium state than protons in mobile domains. Measuring the decay signal at two characteristic times provides a ratio which corresponds to the samples crystallinity.

Measurement

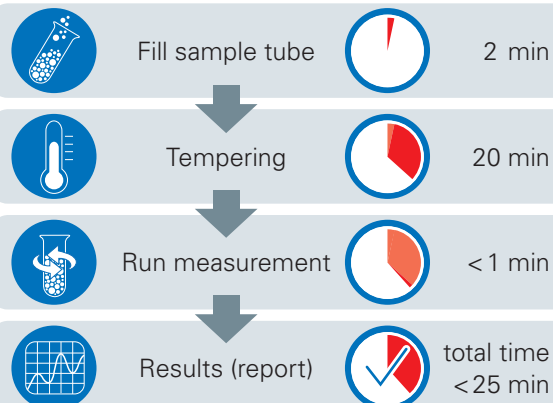


Calibration

- Calibration range: 17 – 96 % crystallinity / 853 – 998 kg/m³
- Typical correlation factors above 0.990
- Typical mean standard deviation below 0.25 % (3.77 kg/m³)
- Typical mean standard deviation of repeated measurements below 0.04 % (0.604 kg/m³)

The method is calibrated with 3 to 5 samples of known crystallinity. NMR values (ratios) are related to crystallinity and/or density by linear regression. Bruker-certified standard samples are provided for back-up calibration.

Workflow



Recommended Equipment

- minispec mq one Polymer Analyzer for routine measurements
- minispec mq20 series for R&D and routine measurements
- Tempering block
- Automation (optional)

Beyond Quality Control

- minispec mq20 for in-depth PE research
- up to + 200°C
- T₁ and T₂ relaxation time measurements
- NMR signal fitting routine

