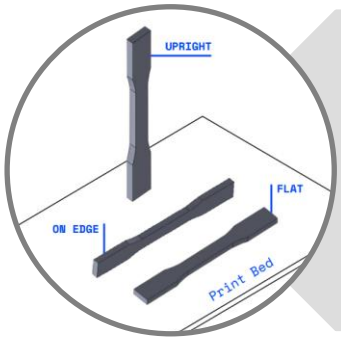
Irradiation damage on 3D printed high performance polymers for accelerator magnets

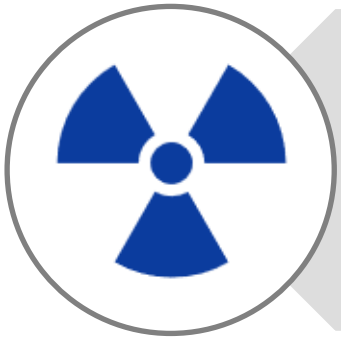
Julia Vielhauer, TE-MSC-SMT
Technical Student, Material Science
Supervisor: Christian Scheuerlein
Start date: 01/04/2024

Concept



FDM - Printing

- 3 materials: ULTEM9085, PEEK, Helios PEEK
- 3 orientations

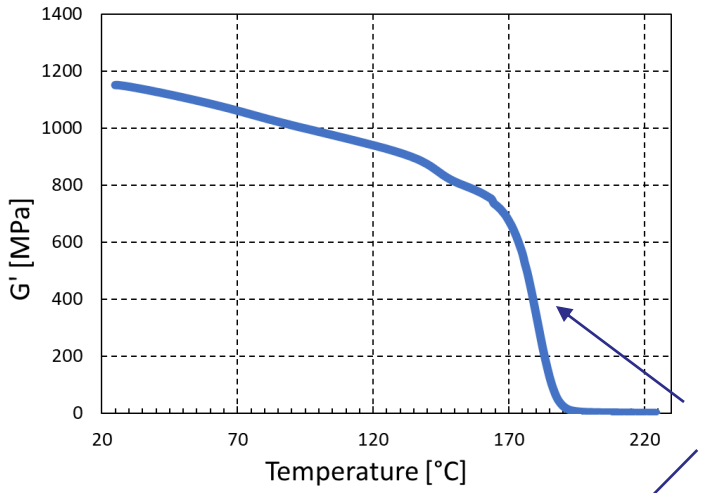


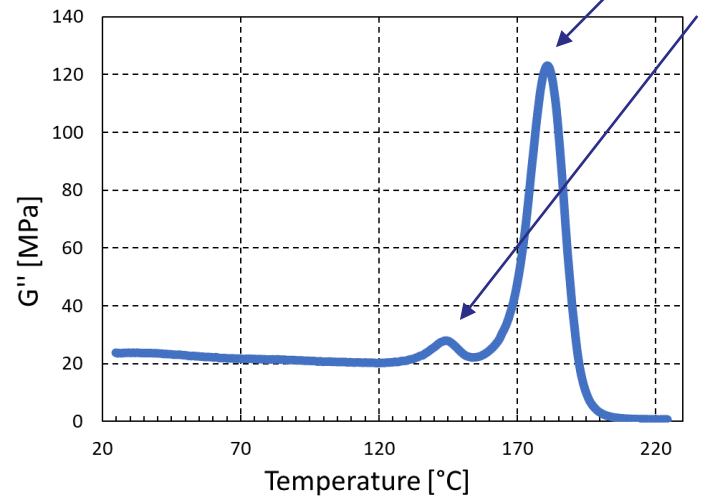
γ - Irradiation

- ^{60}Co source in air
- By now 5 MGy, planned up to 30 MGy

Characterization

- DMA
- Short beam tests
- Impact tests

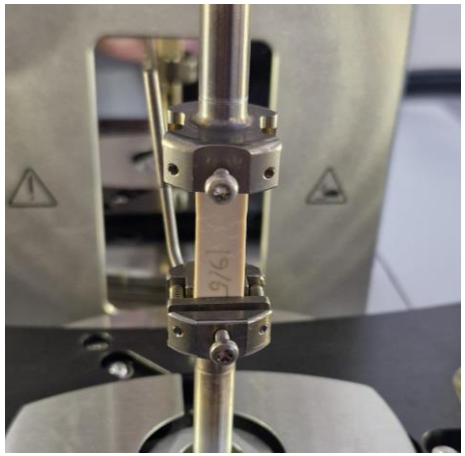




ULTEM, XZ orientation, 0 MGy

Dynamic Mechanical Analysis

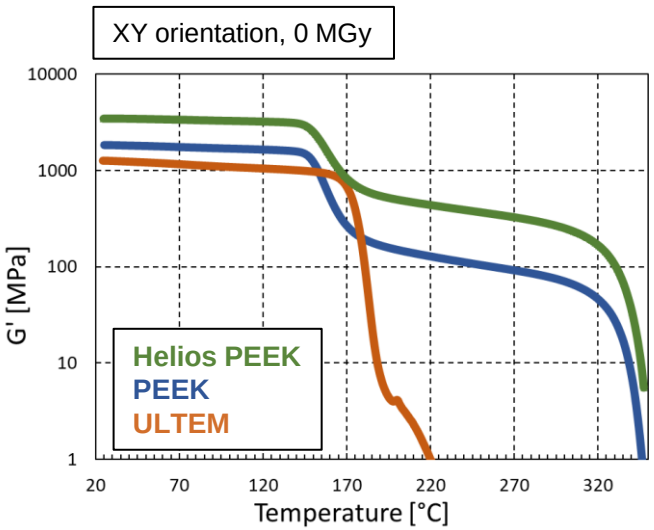
- storage modulus G': stiffness
- loss modulus G'': viscous losses
- monitor glass transition
- other relaxation processes



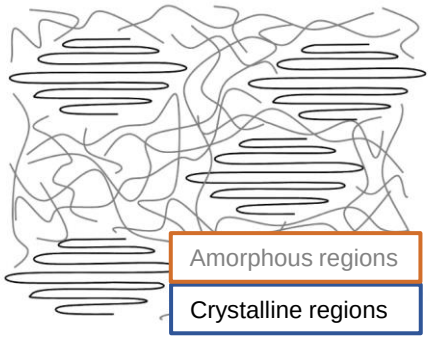
"Roboze ULTEM AM9085F", Technical Data Sheet, (2021)

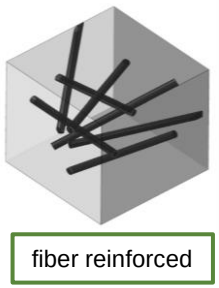
Properties are influenced by

Type of Material

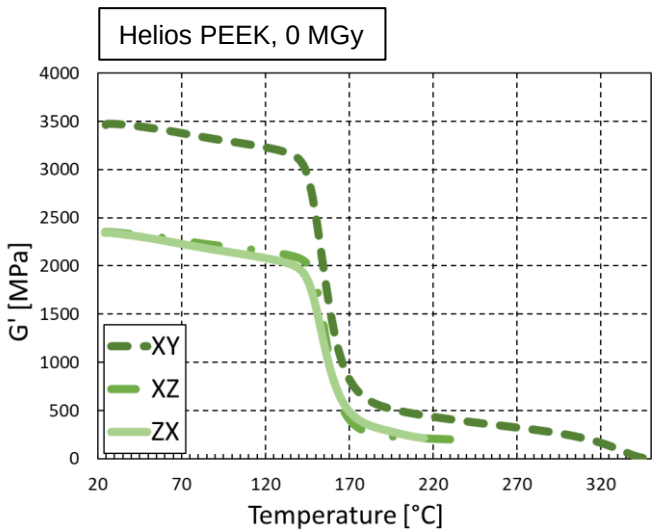


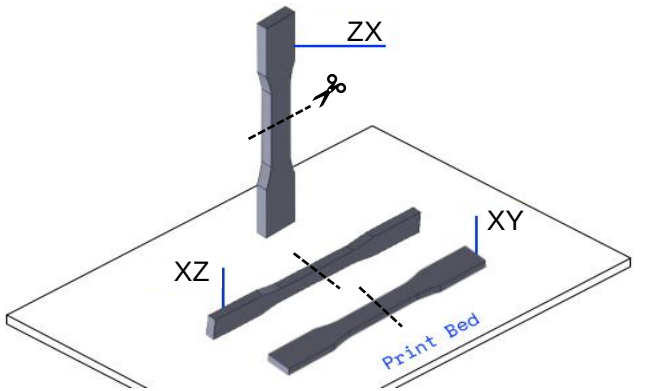
- Chemical structure
- Microstructure
  - Amorphous, semicrystalline
- Additives
  - Ceramic fibers

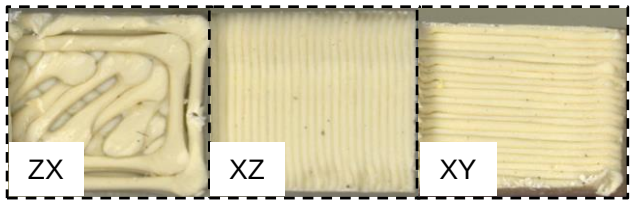




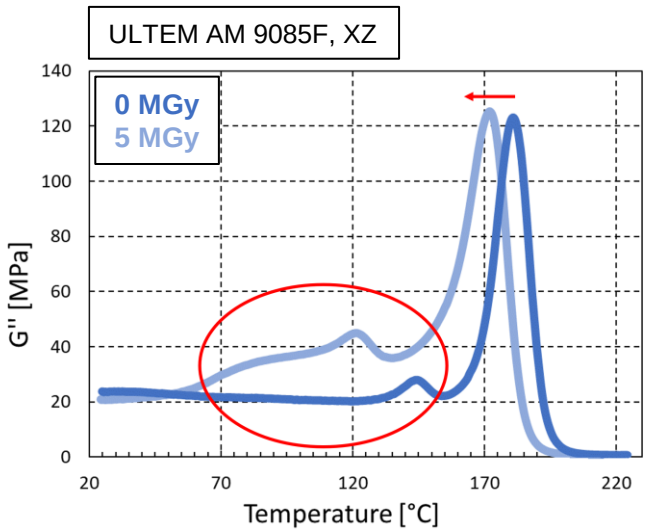
Printing orientation



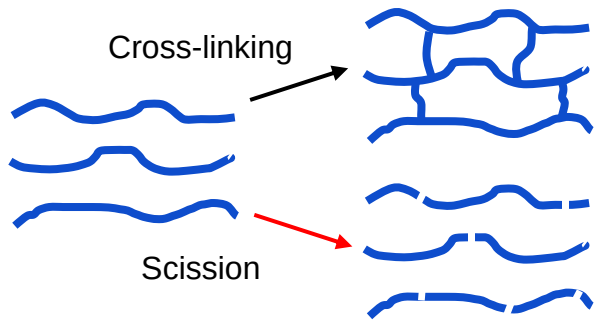




Irradiation Dose



- Glass transition depends on molecular weight M_n
  - M_n ↓ → T_g ↓



Fliegener, S. „Micromechanical finite element modeling of long fiber reinforced thermoplastics.“ Diss. Karlsruhe, KIT, 2015.
Gaarud, A. “Thermomechanical properties and fracture behaviour of polymers”, TE-MSC-SMT Section Meeting, EDMS No. 2767951, (21/07/2022)
Fox, T. G., and Flory P. J. "The glass temperature and related properties of polystyrene. Influence of molecular weight." Journal of Polymer Science (1954)

Julia Vielhauer

Click to edit Master title style