» Characterization and Process Monitoring of Selective Laser Sintering for Reclaimed High-Temperature-Resistant Polymers

PROJECT ID: B4-18

Principal Investigators:
Margaret Sobkowicz Kline (UMass Lowell)
Xu Chen (UCONN)

Student Researchers:
Varun Venoor, Akanksha Patel, Nicholas Bowen, Hikma Abajorga (UMass Lowell)

IAB Mentors:
Thomas Anthony (HP)
Rich Baker (Integrity)
Scott Eastman (United Technologies)
Paul Olubummo (HP)
Lihua Zhao (HP)

The objective of this project was to gain critical knowledge for selective laser sintering (SLS) additive manufacturing (AM) of reclaimed polyether ether ketone (PEEK) materials, by a quality-driven systems framework integrating material characterization, in-situ monitoring, and process controls. PEEK is a strong, light, thermally and chemically resistant, and biocompatible polymer of interest for SLS printing in medical, aerospace, automotive, energy and semiconductor industries. The challenges of SLS printing of PEEK are that the high temperature process is complex, the powder materials are high cost, and significant wastage of powder occurs due to its single use in the process. This project combined materials characterization and in-situ measurement of the printing qualities to understand the effects of thermal aging on PEEK powders.

Characterization techniques included spectroscopy for chemical structures, calorimetry for thermal transition changes, microscopy for powder morphology, x-ray diffraction for crystallinity changes and rheology and powder flowability testing. Results indicate that the PEEK crystallinity and viscosity increase significantly, both of which may contribute to problems in sintering of thermally aged powders.

Project Benefits: 1) New knowledge critical about feasibility and capability of SLS with reclaimed PEEK materials; 2) Understanding of how recycling impacts the PEEK 3D printing process; 3) Potentially patentable process design guidance (hardware and software) for high-quality SLS PEEK parts while maximizing material usage.

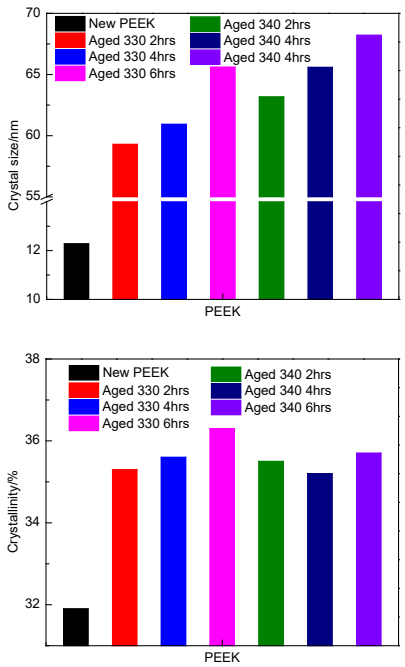

Figure 1. X-ray diffraction results for PEEK powders aged 0 to 6 hours. (top) crystal size and (bottom) percent crystallinity.

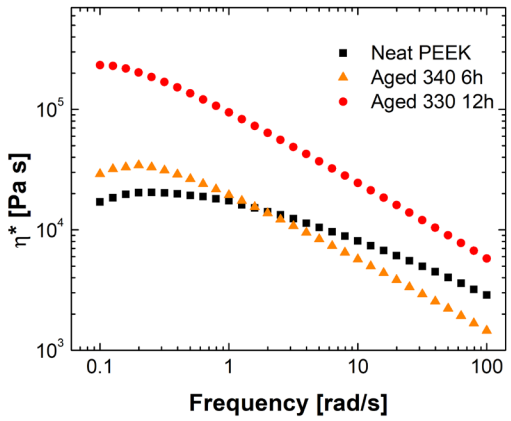

Figure 2. Parallel plate rheology results for as-received and thermally aged PEEK powders.