Space Technology Mission Directorate (STMD)
GRC Center Innovation Fund – FY25

Digitally-Engineered Impact Resistant Aerogel Composites for MMOD Protection (DIRAC-MP)

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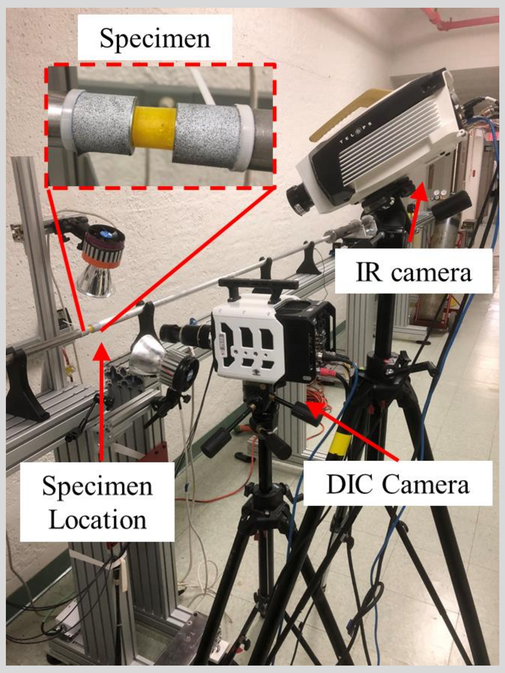
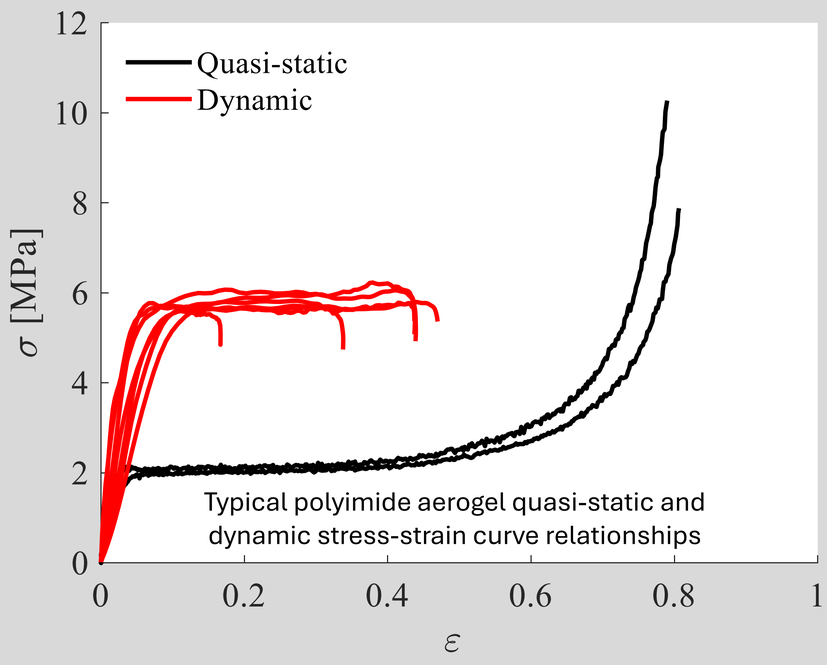
Summary

This project implemented a digital-engineering approach to optimize the impact absorption performance of polymer aerogels and aerogel-based composites for Micrometeoroids and Orbital Debris (MMOD) containment. We developed a curated materials database and a machine-learning framework to derive composition-response relationships, enabling predictive design and targeted material selection. In support of experimental validation, a split Hopkinson pressure bar (SHPB) test rig, specifically adapted for low-density aerogel materials, was designed and built in-house. This project accelerates the development of new aerogel formulations, producing candidate materials tailored for enhanced impact-absorption behavior.

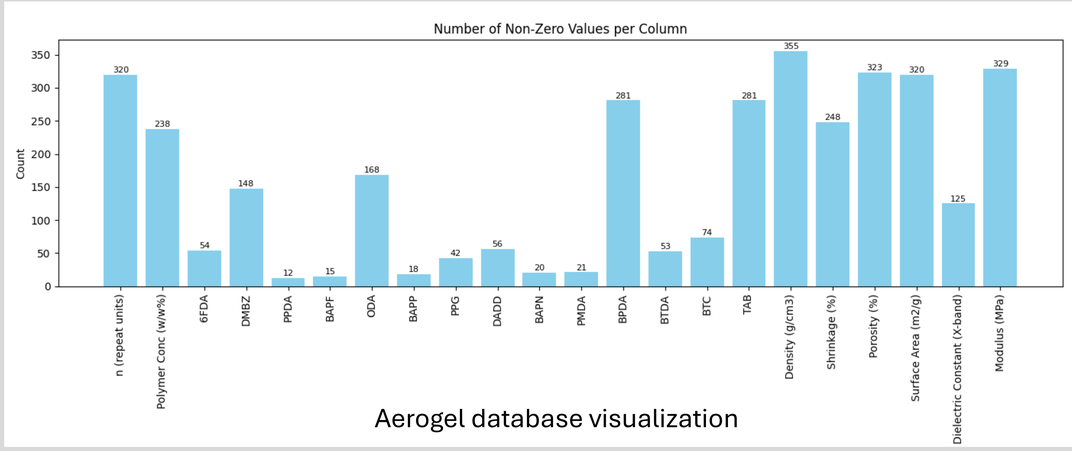
GRC Modified Split Hopkinson Pressure Bar



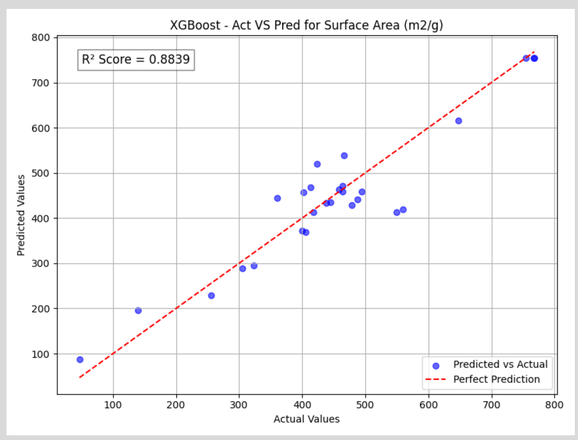


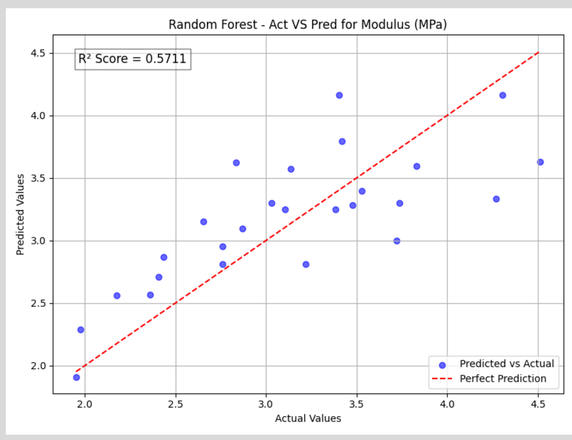
Machine Learning

1. Built ML models to support material selection for high-modulus polyimide (PI) aerogels.
2. Cleaned and curated experimental data with multiple output target.
3. Achieved promising R^2 scores for predicting Surface Area.
4. **Next Steps**: Continue hyperparameter tuning and model comparison.



Aerogel database visualization





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