The Effect of Microballoon Density and Strain Rate on the Properties of Syntactic Foam Composites

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Composite Materials & Mechanics Laboratory
Innovation in Micro and Nano Composites

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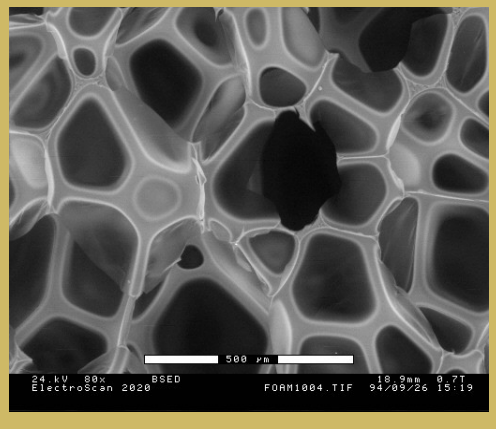
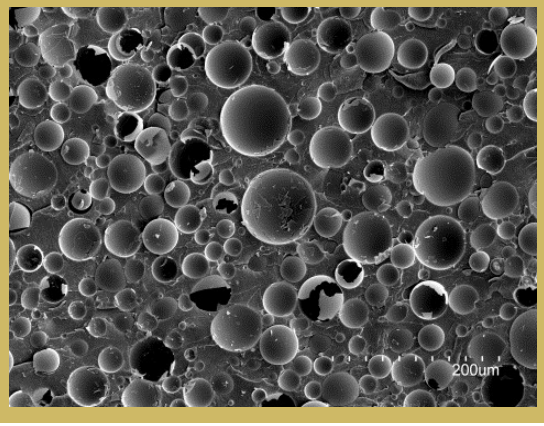
Composite Materials

- When 2 or more materials are combined in hopes of maximizing the materials strengths while minimizing their weaknesses. The two entities retain their physical and chemical structure.
  - Plywood
  - Concrete
  - Syntactic Foams

Composite Foams

Open Cell Foams	Closed Cell Foams
	
A matrix which can consist a wide range of resins and hardeners that are combined with microballoons.	
Open cell foam: This gives no control over the type or the amount of porosity to be embedded in the foam.	**Closed cell foam:** Control the porosity content in the foam.

Microballoons

Wall thickness

The density of microballoons can be changed by changing the wall thickness of the spheres.

Syntactic Foam Applications

Underwater vehicles

- Locating a lost hydrogen bomb in the Mediterranean Sea in 1966
- Exploring the first known hydrothermal vent sites in the 1970s
- Surveying the wreck of RMS Titanic in 1986

Syntactic Foam Applications

USS Zumwalt class destroyer with syntactic foams modulus for buoyancy and radar transparency

Syntactic Foams/Density

Microballoon Type	Foam Type	Theoretical Foam Density (kg/m3)	Average Experimental Density
S22	SF220-40	784	812.4
S22	SF220-50	690	608.5
S22	SF220-60	596	706.3
K46	SF460-40	880	870.4
K46	SF460-50	810	793.1
K46	SF460-60	740	698.5

Specimen Preparation

Glass microballoon

Mechanical stirrer

Epoxy resin

Hardener

Aluminum molds

Mechanical stirrer

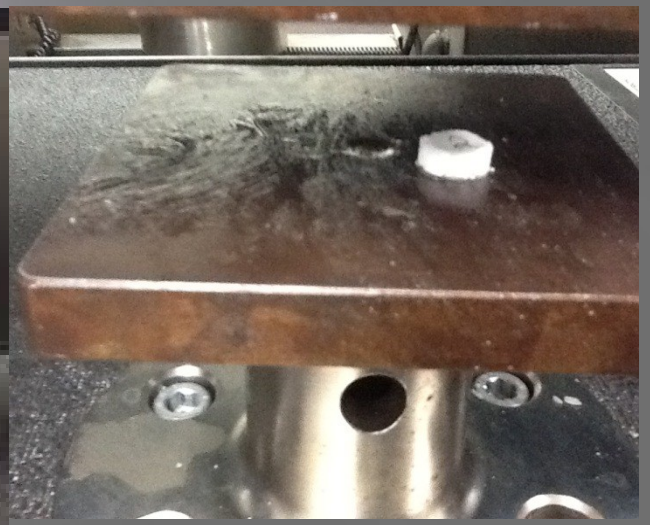
Specimen Preparation

The cast syntactic foam slabs (compression test specimens have been drilled out of them)

Experimentation

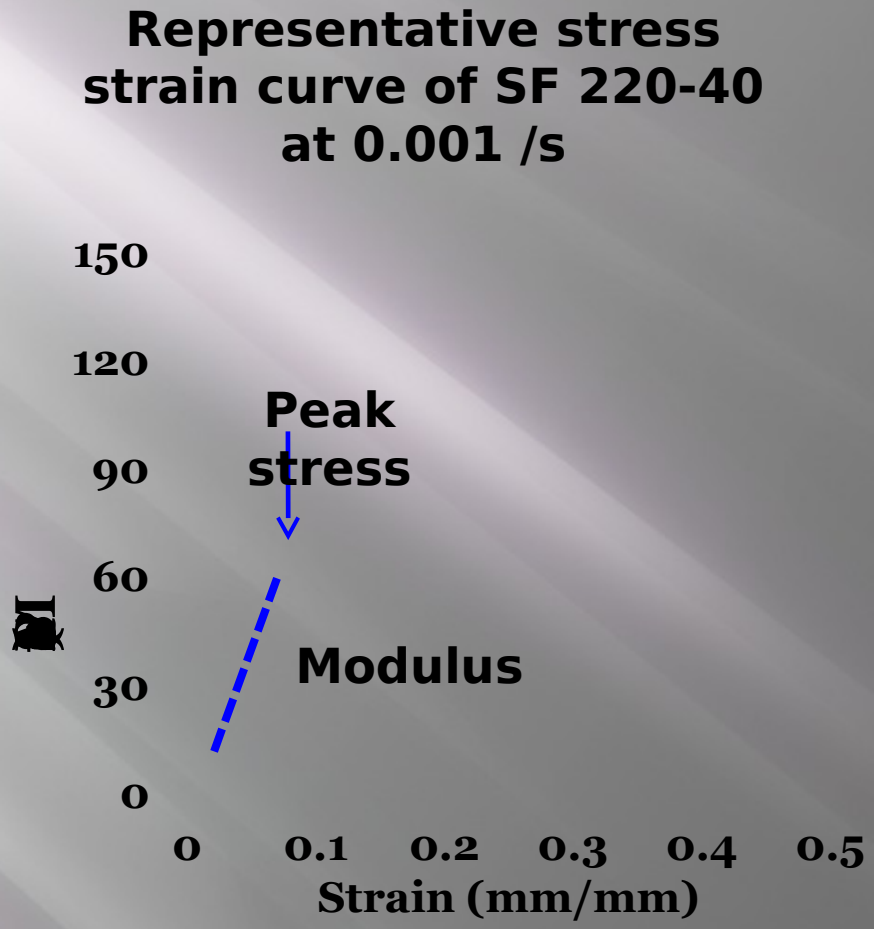
- **Strain: the ratio of change in the length to the original length of the sample**
- **Strain Rate: the rate of change of strain with respect to time, *t***
- **Static Testing: compression which occurs at slow rates over time**
- **Stress: the average force per unit area**
- **Modulus of Elasticity: slope of the initial linear elastic region**

Quasi-Static Compression Tester

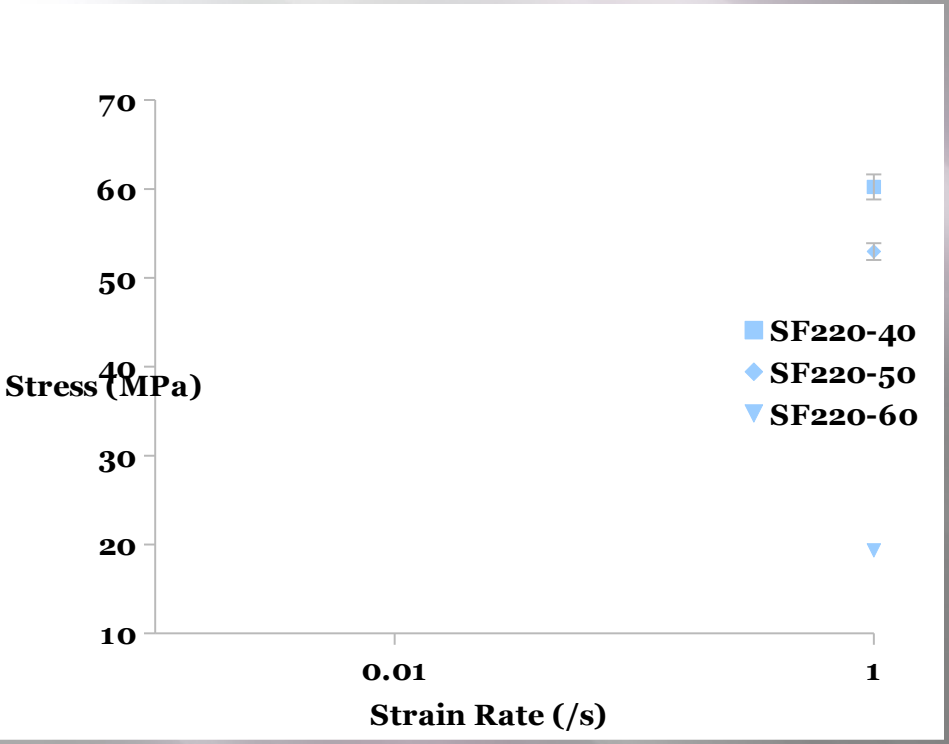


Syntactic Foam sample during and after compression

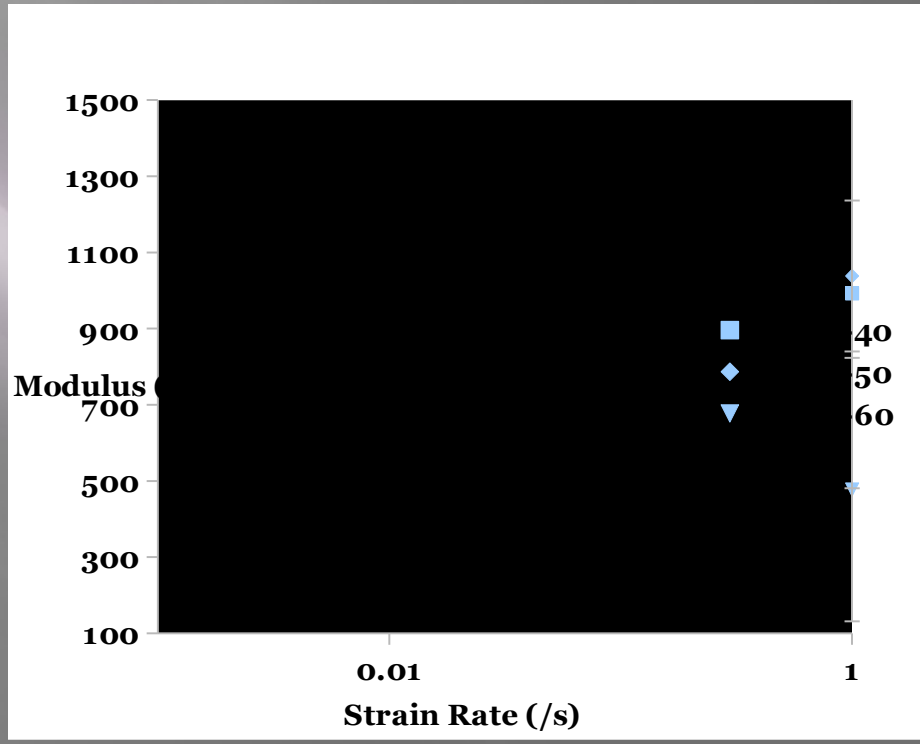
Stress-Strain Diagram



ress and Modulus Averages of SF-220

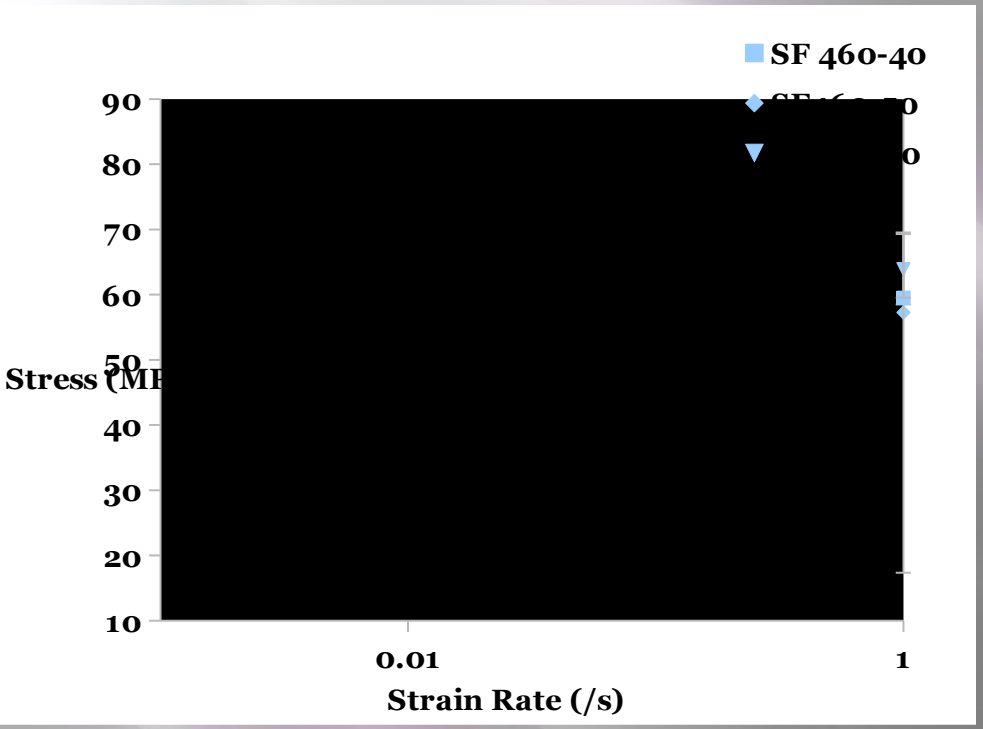


Strength of 220 foams at various strain rates

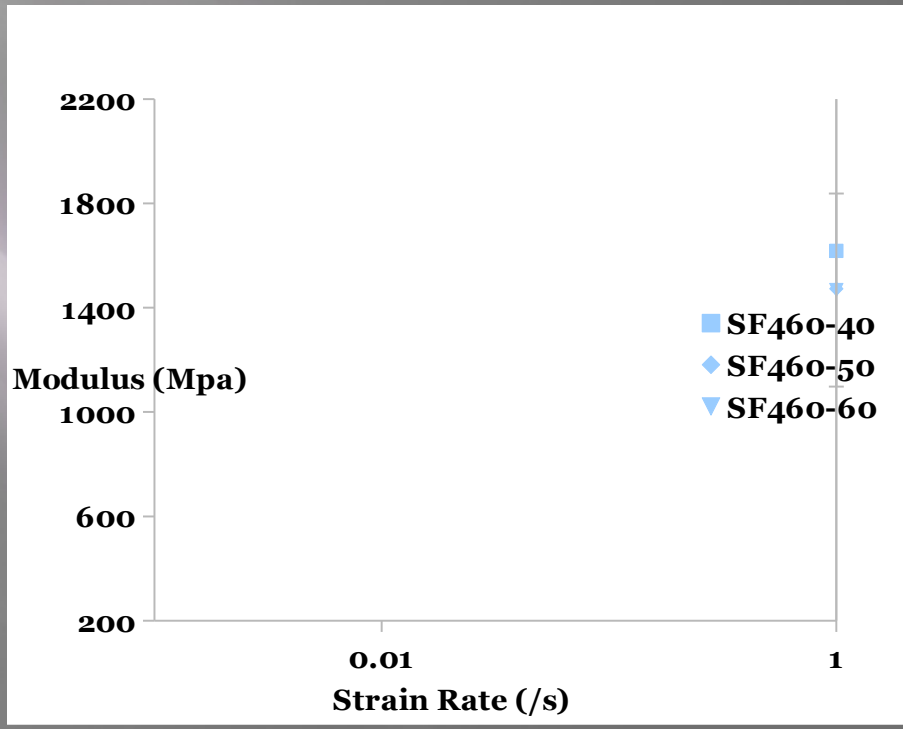


Modulus of 220 foams at various strain rates

ress and Modulus Averages of SF-460



Strength of 460 foams at various strain rates



Modulus of 460 foams at various strain rates

Conclusion

- The two syntactic foams of varying densities were studied at different strain rates from 0.001 to 0.1 /s.

- The Stress was observed to increase with the strain rate for 460 type.

- The modulus values showed an increase with the strain rates for the 220 and 460 type syntactic foams.

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