The Microbond Test – Rubbish In = Rubbish Out?

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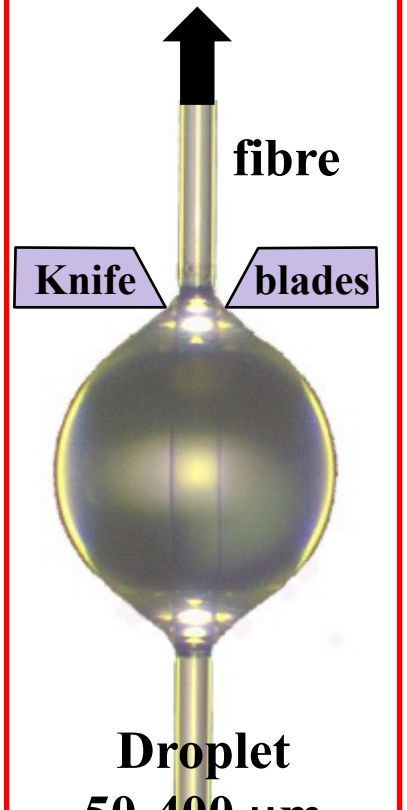
The Rubbish In, Rubbish Out Concept

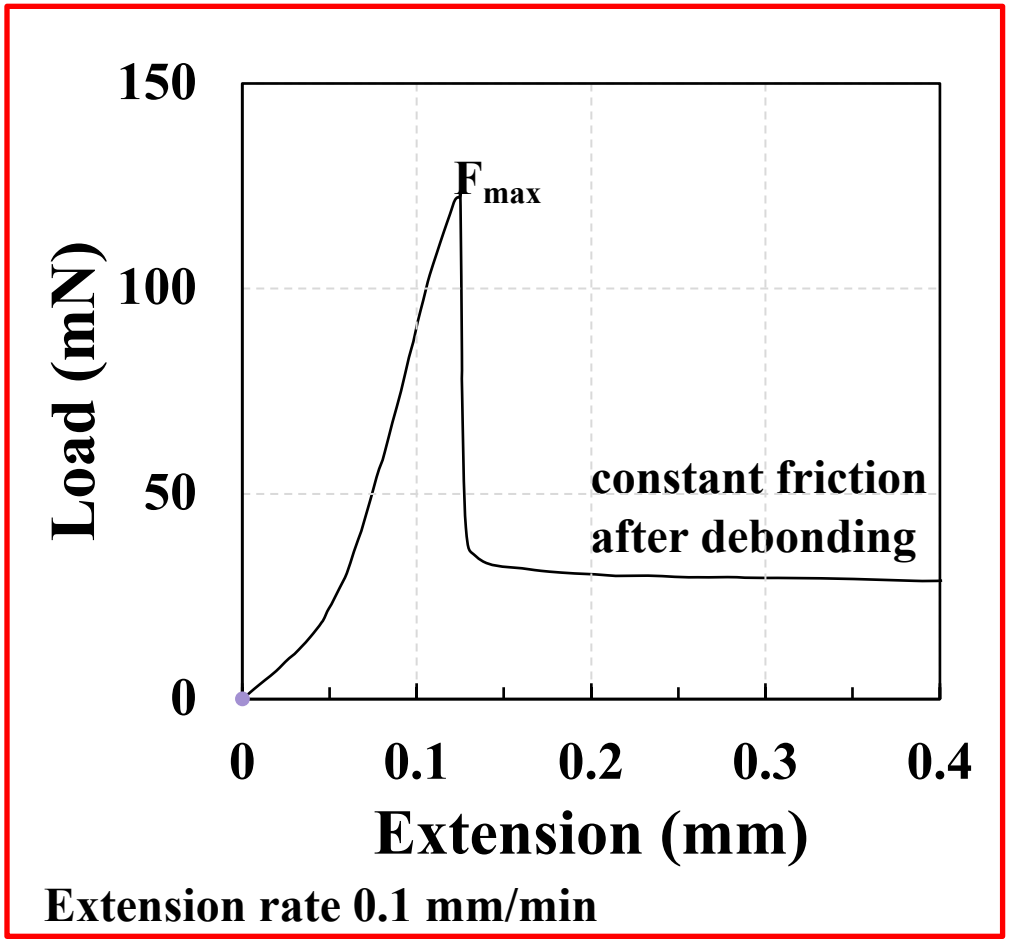
- **The Rubbish In, Rubbish Out (RIRO) concept is used in computer science and other fields to express the idea that, incorrect or poor quality input will always produce faulty output.**
- **Note: RIRO says nothing about the analysis method which may be flawless and work perfectly.**

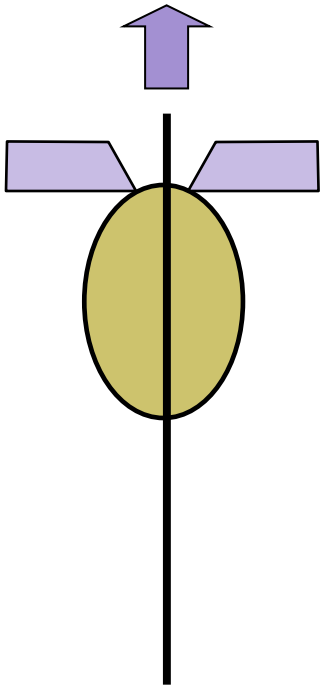
RIRO Applied to Experimental Research

No matter how 'perfect' the test equipment, a 'faulty' sample will give 'faulty' results

Microbond Test for IFSS







Assuming shear stress is distributed uniformly around the interface then -

Average IFSS: $$\tau = \frac{F_{max}}{A_e}$$

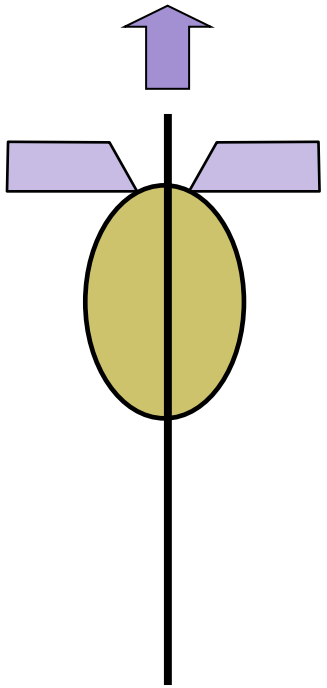
Composites Pt.A 41 (2010) pp 1077-1083

The Microbond Test

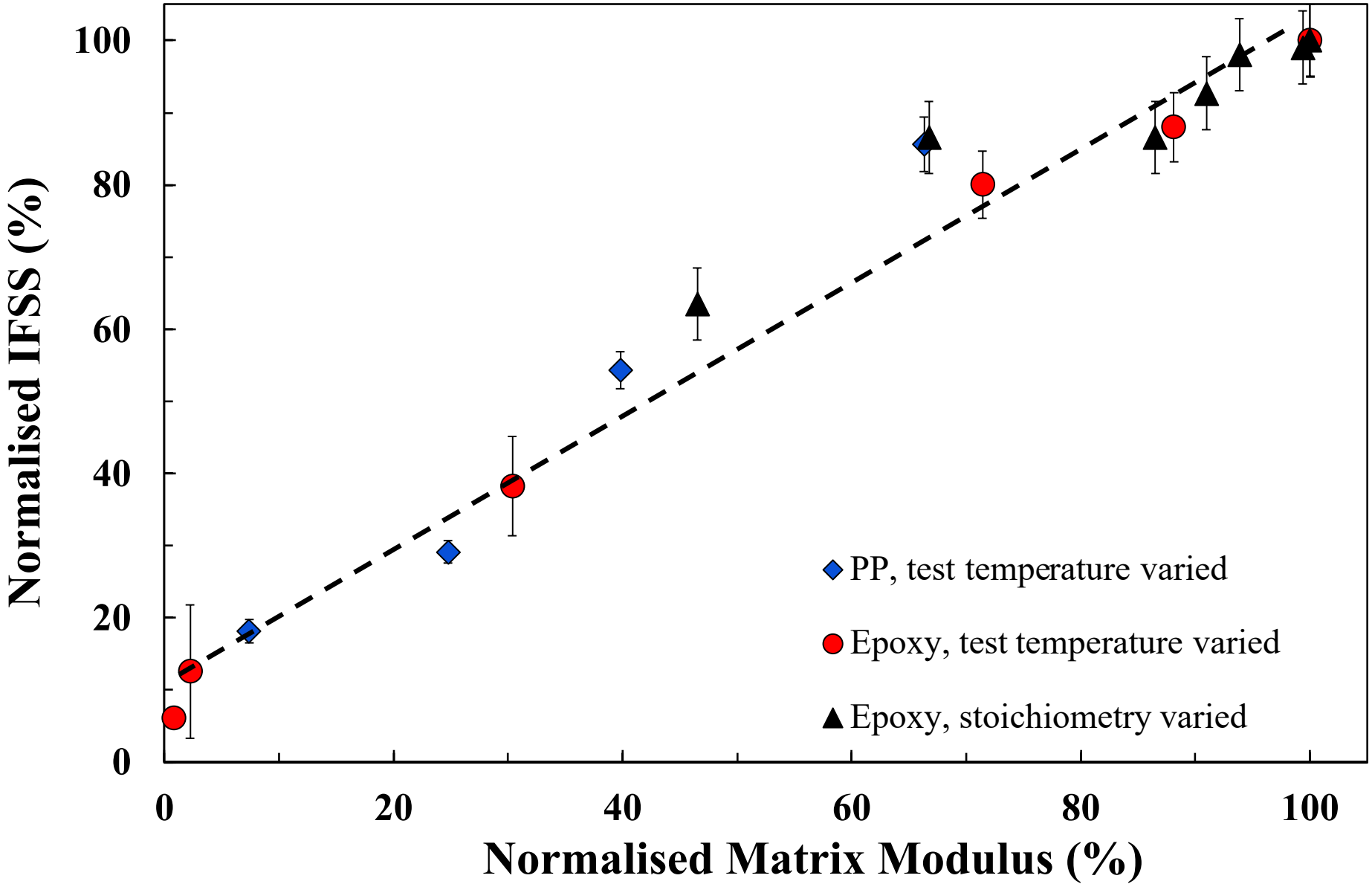
- **Note that the force is not applied directly to the interface in this test**
- **The applied force acts on the interface via the polymer "matrix"**
- **So it may be expected that polymer droplet properties will affect the results of the test**
- **So to screen for interface effects –**

  - the droplet properties should not change from droplet to droplet in a single system

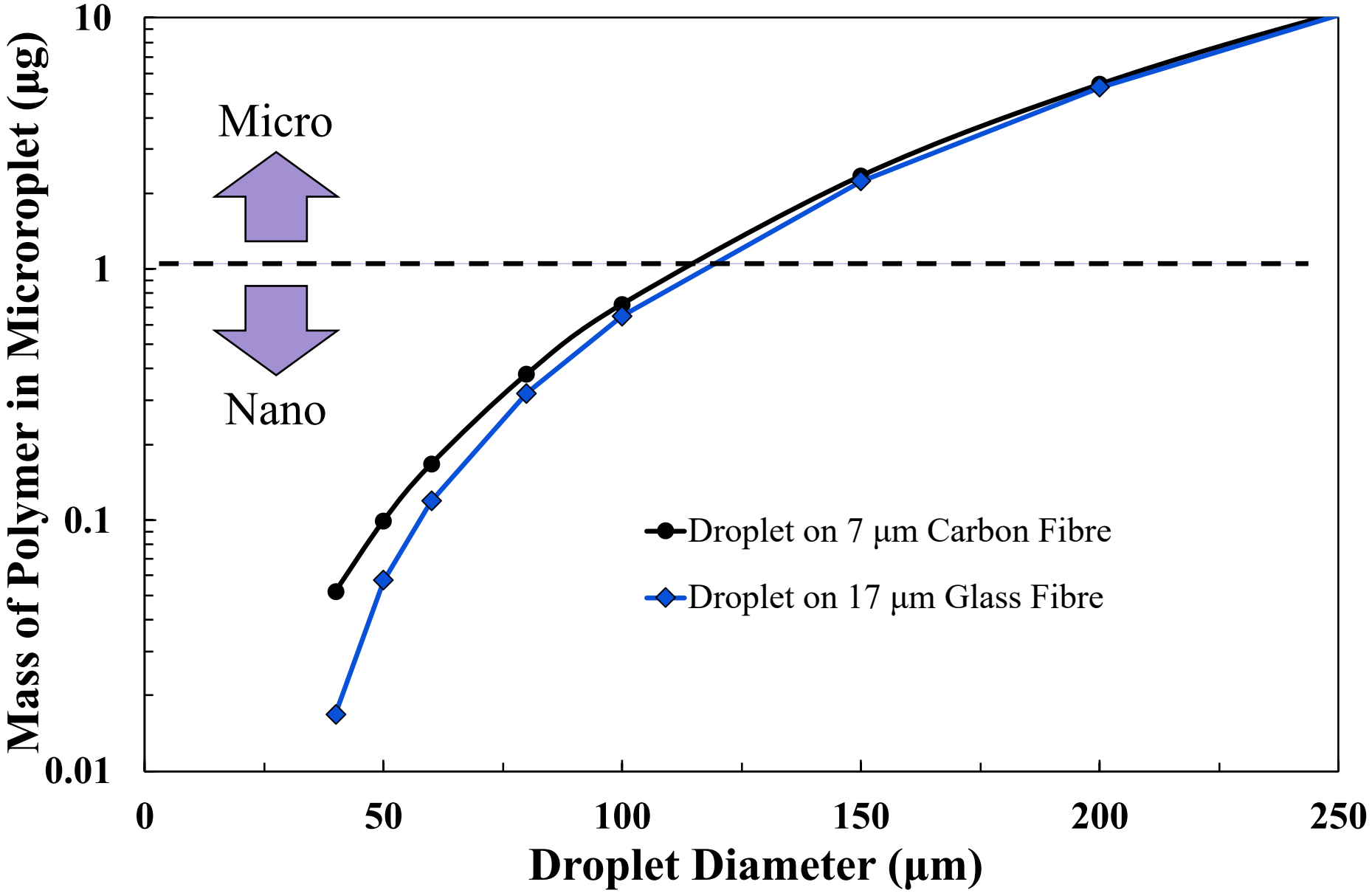
  - or from system to system if comparing interface effects between systems



Microbond IFSS vs Polymer Modulus



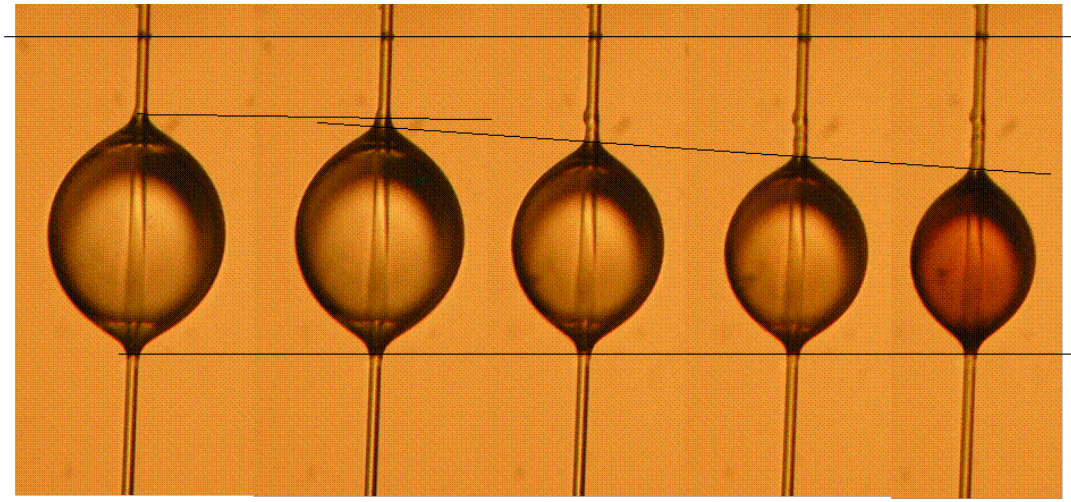
How Big is a Microdroplet ?



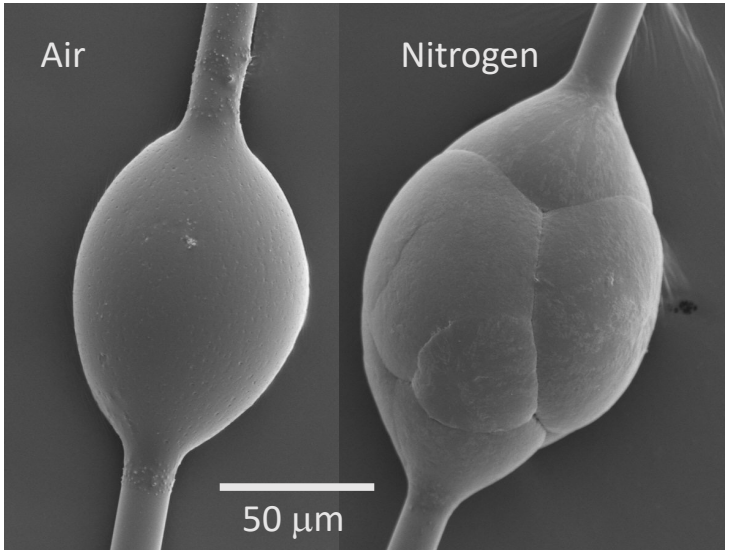
Why Might Polymer Microdroplet Properties Differ From Expectations ?

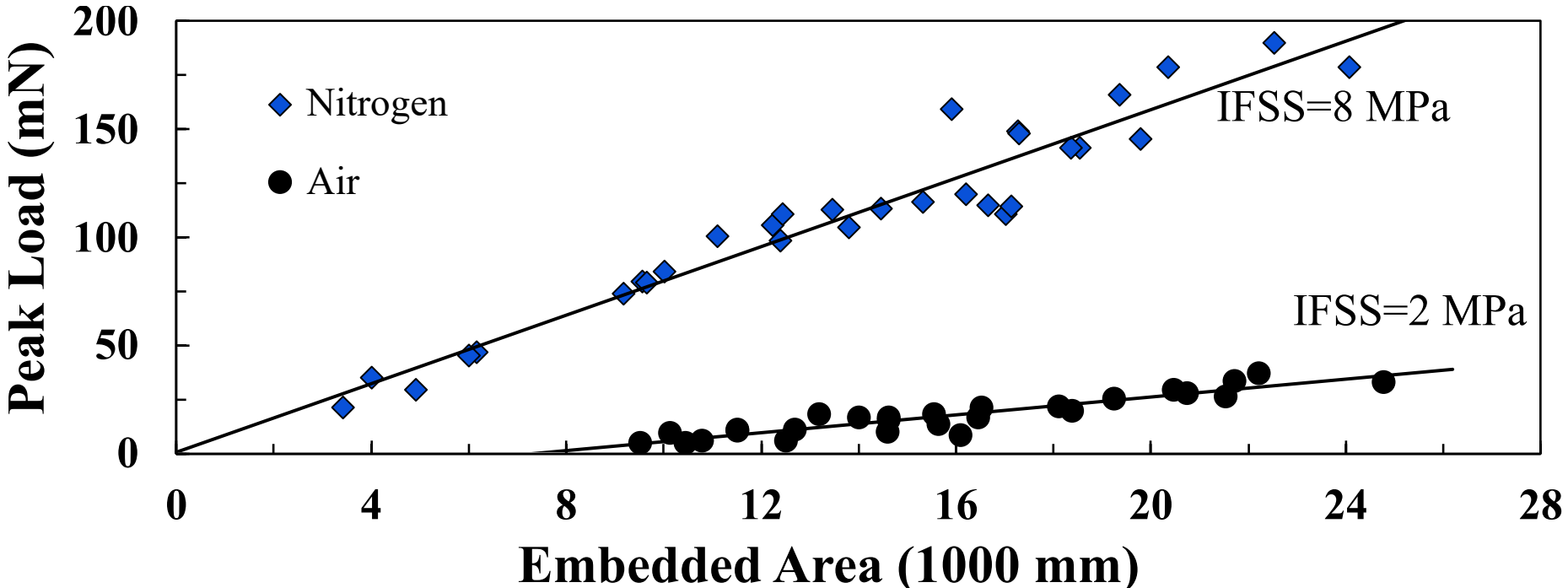
- **Crystalline structure of thermoplastics**
- **Polymer degradation effects**
- **Droplet morphology**
- **Moisture absorption**
- **Mixing effects**
- **Curing differences**
- **Evaporation of components**
- **Oxygen inhibition of cure**
- **Unexpected chemical interactions**
- ***…see.. Polymer Testing 111 (2022) 107591***

PP Droplet Degradation

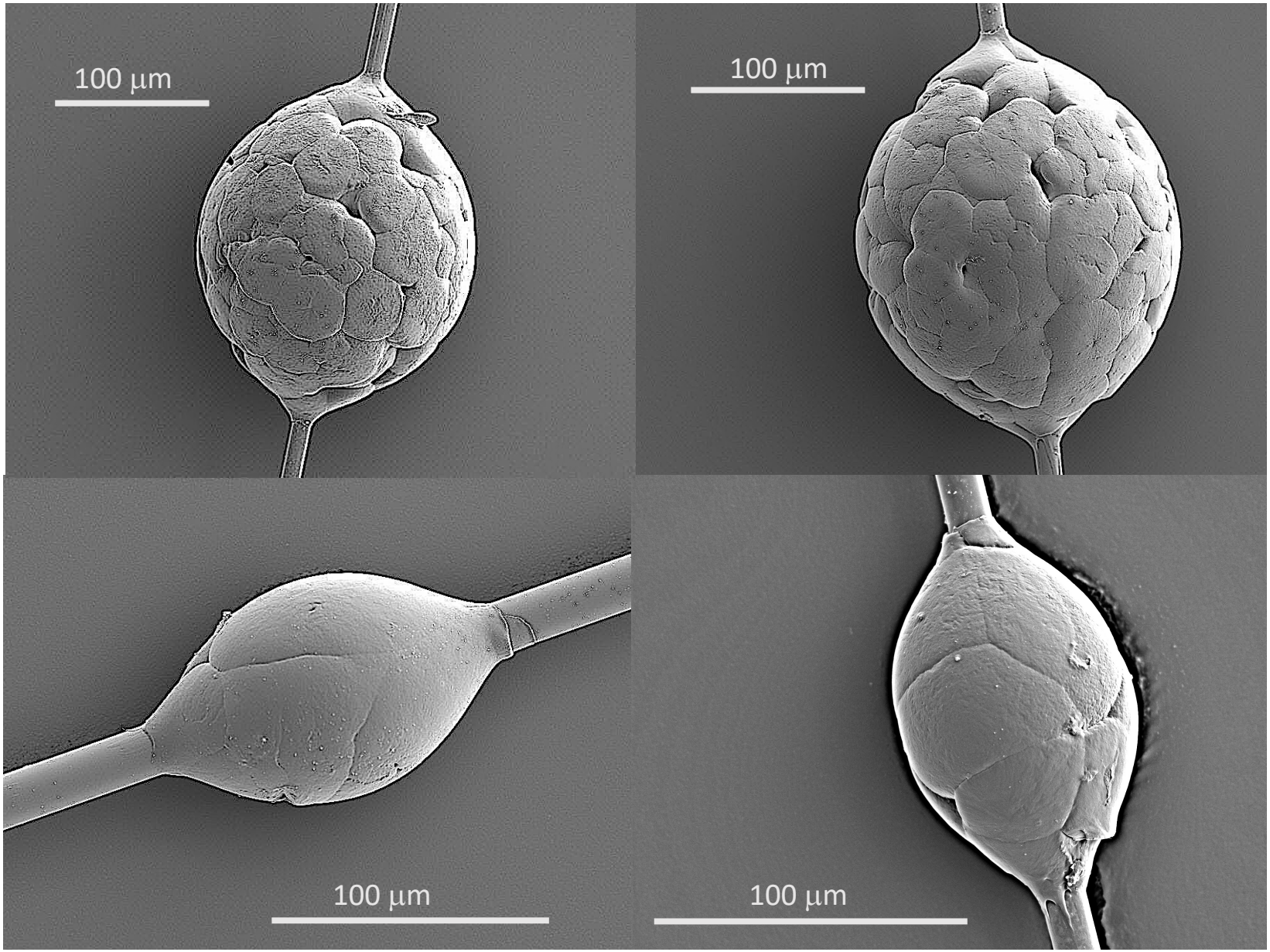


PP47 - Minutes at 220°C

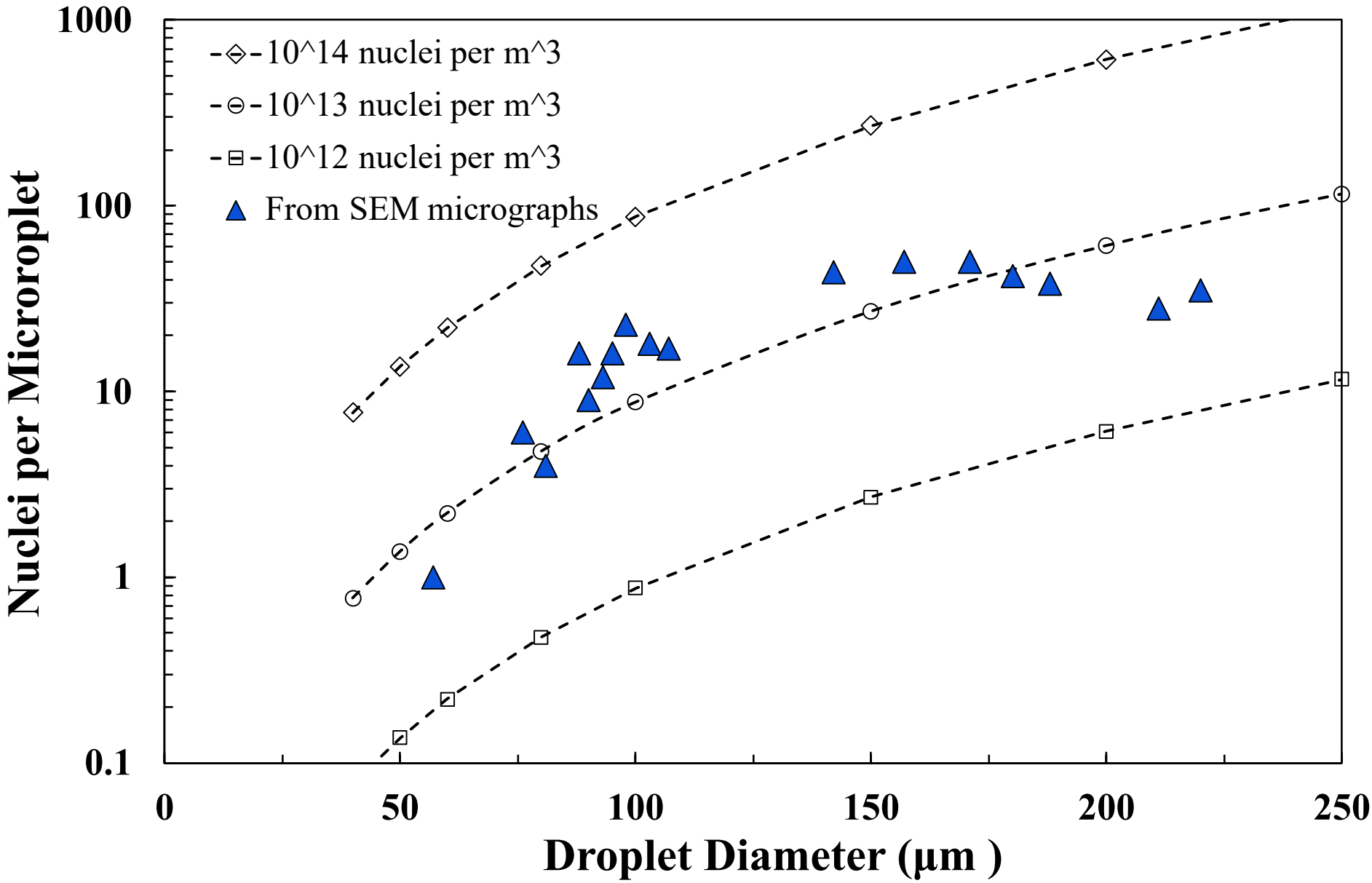




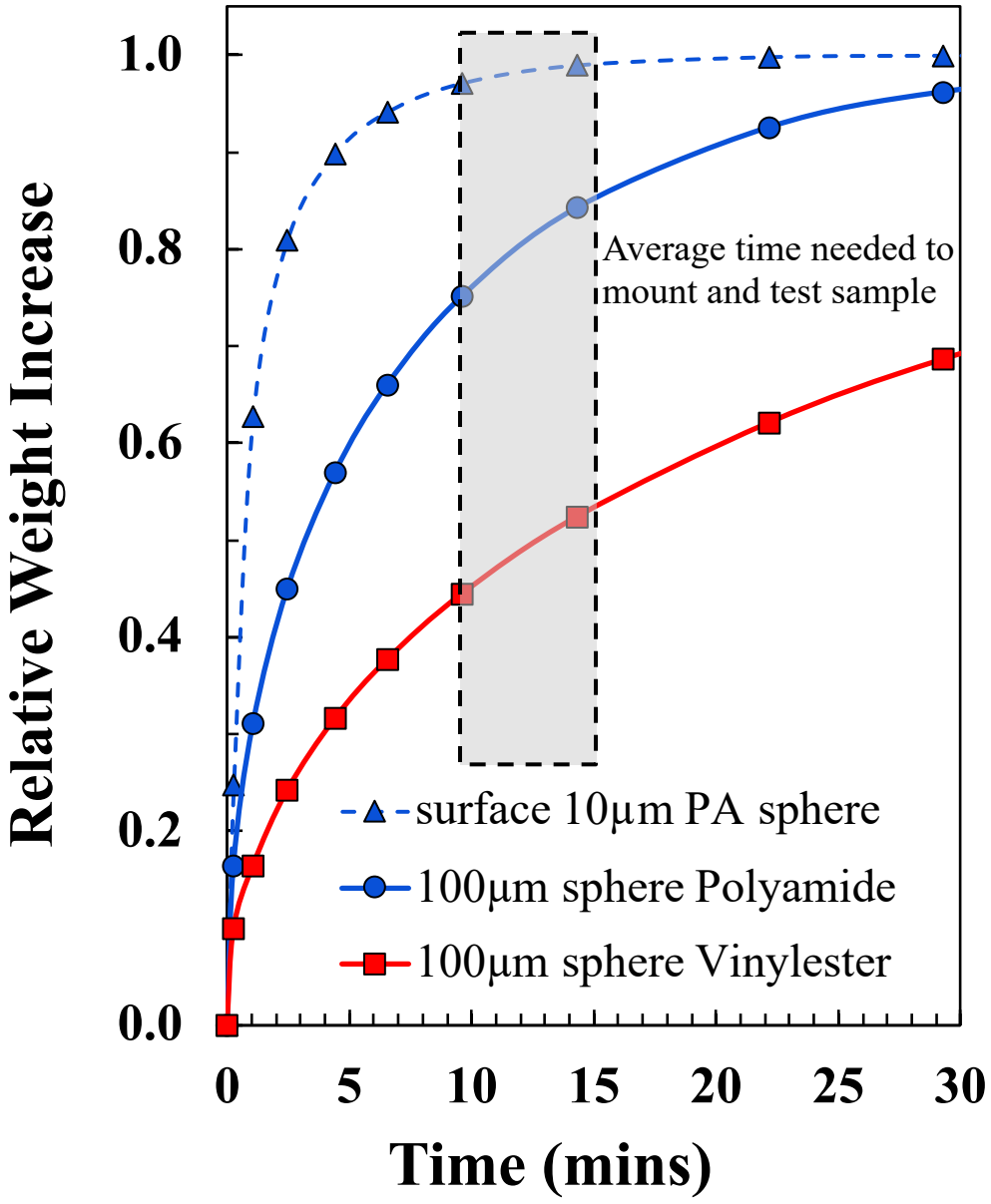
SEM of PP Microdroplets

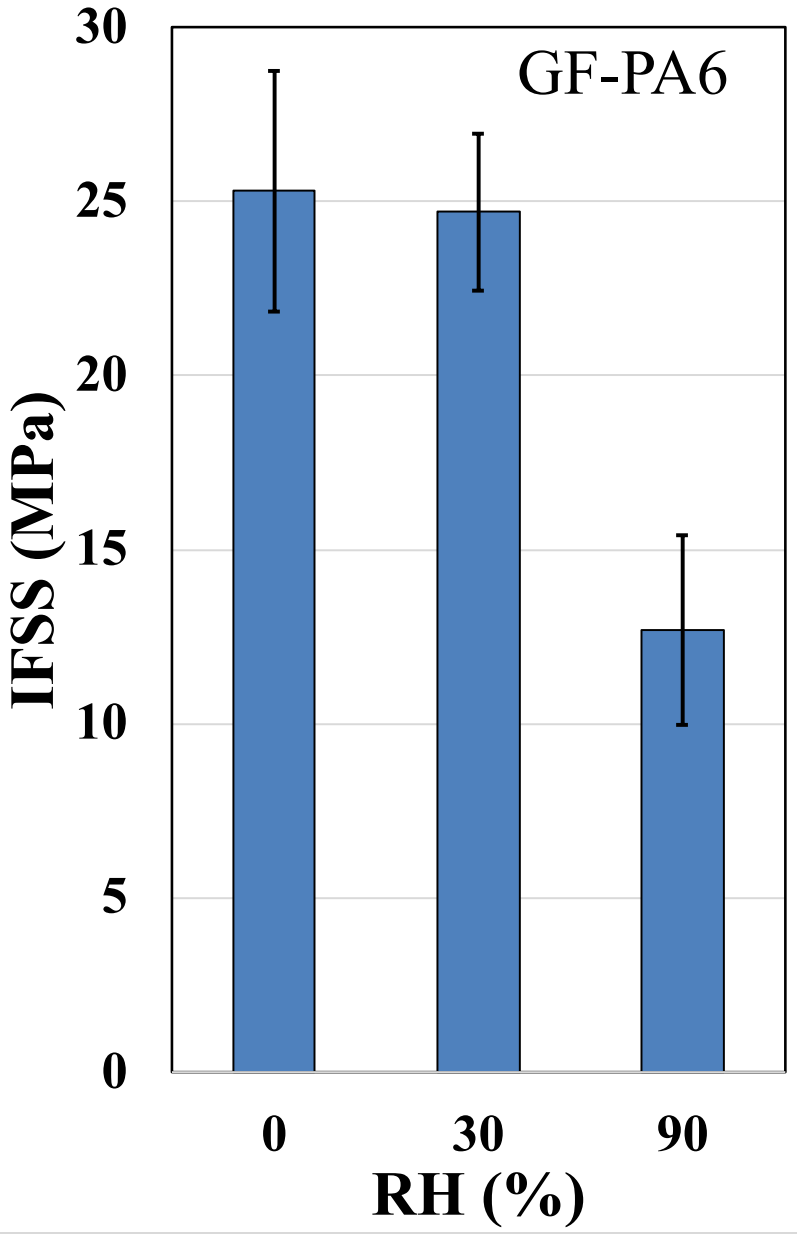


How Many Spherulites in a Microdroplet ?

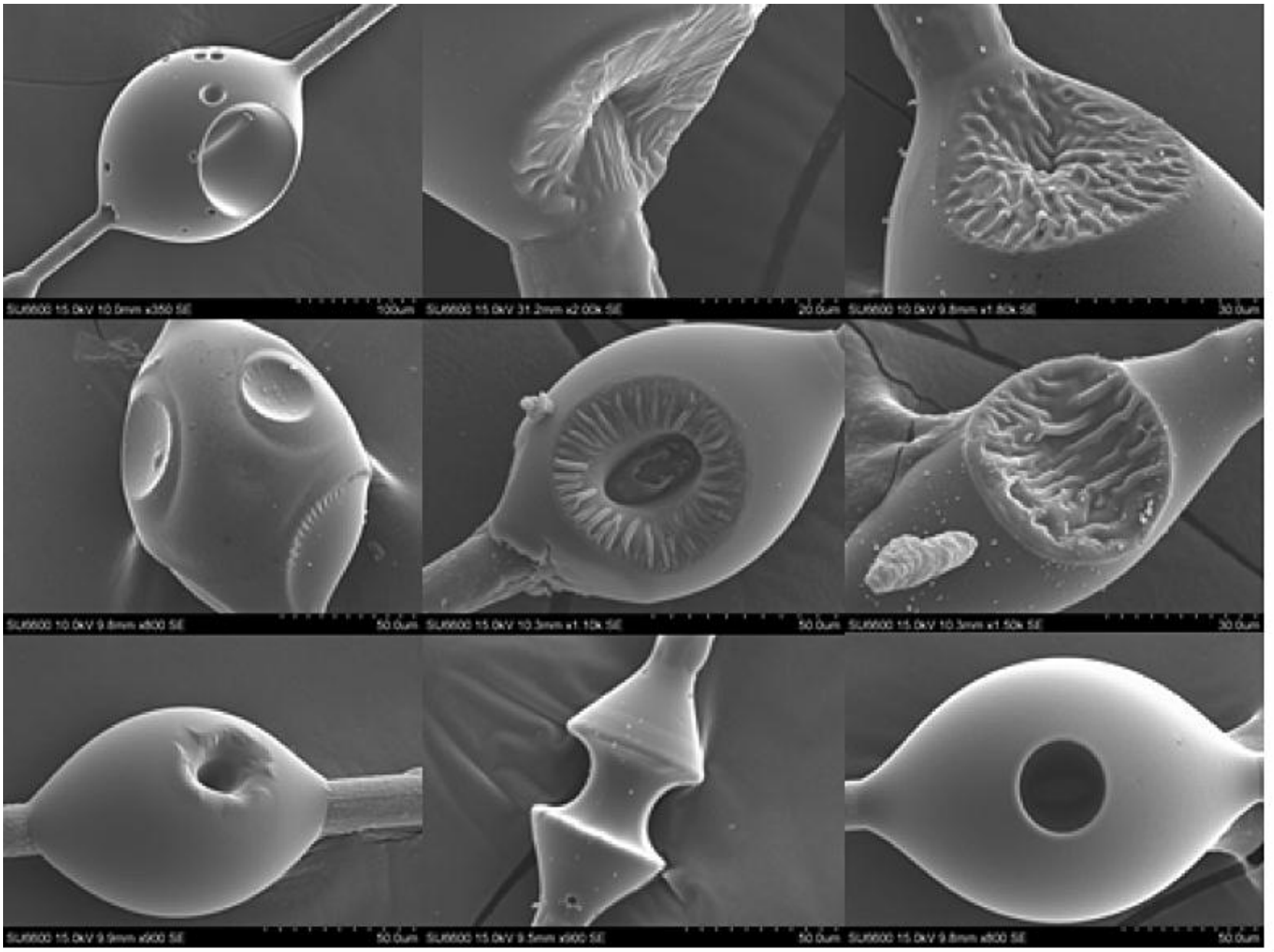


Moisture Absorption by Microdroplets



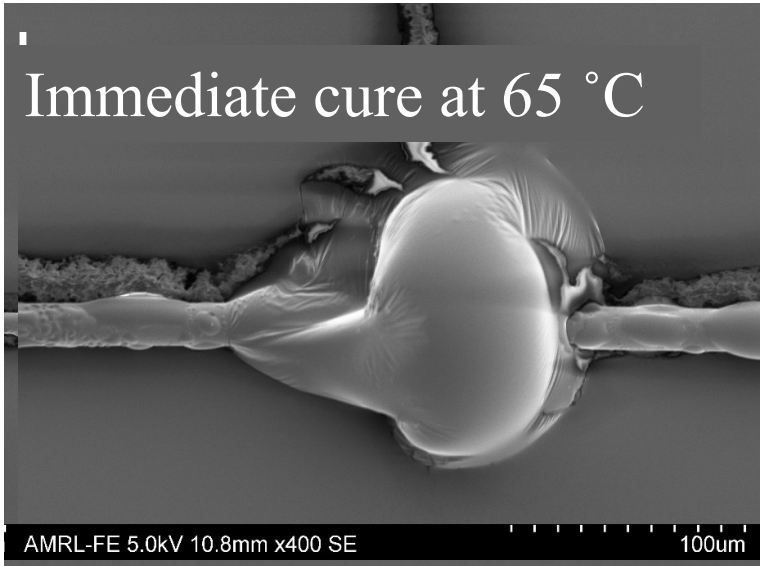


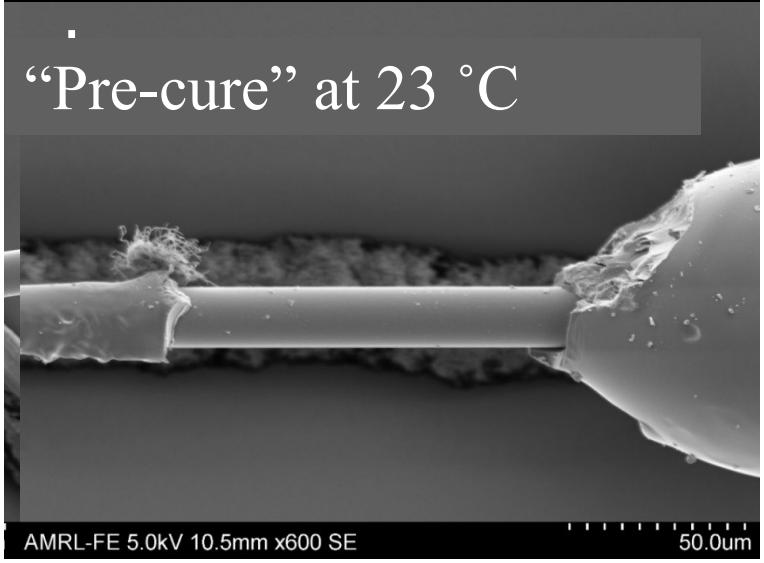
SEM of Epoxy Microdroplets

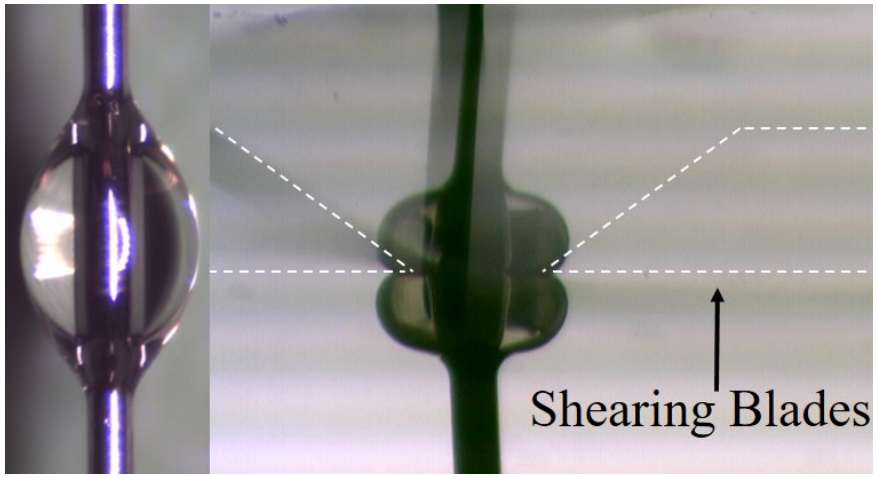


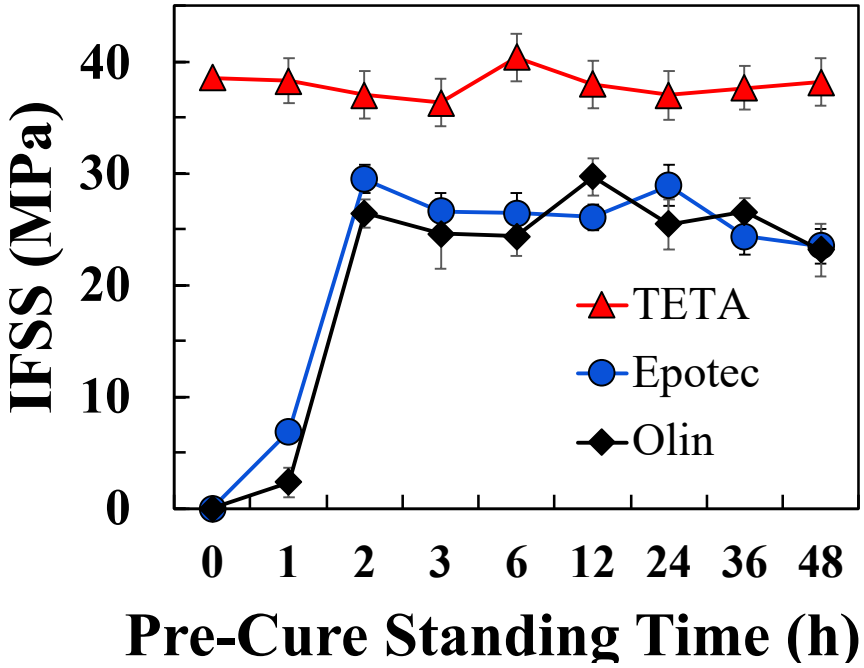
IOP Conf. Series: Materials Science and Engineering **139** (2016) 012048 doi:10.1088/1757-899X/139/1/012048

Curing Epoxy-Amine Microdroplets



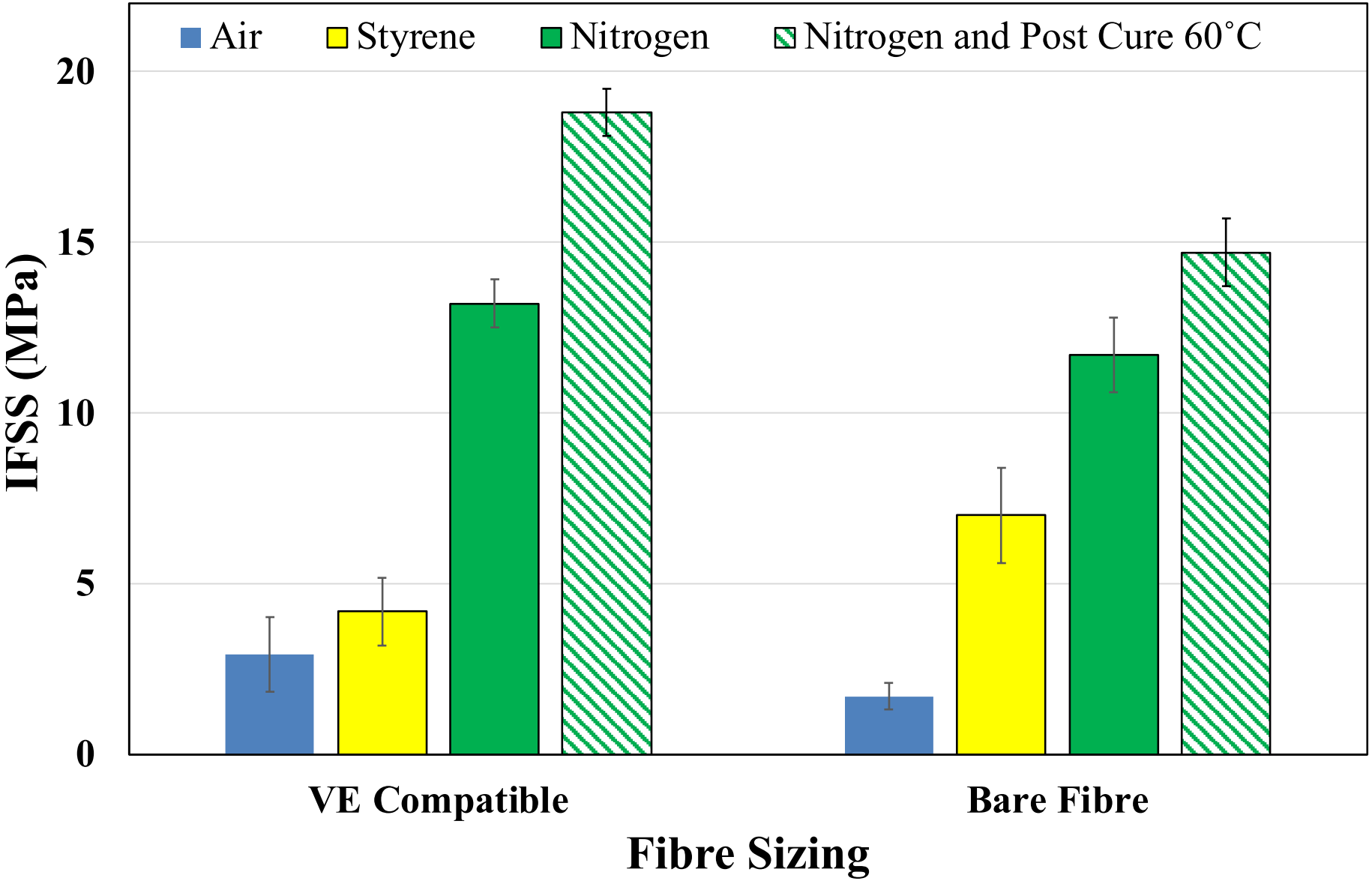






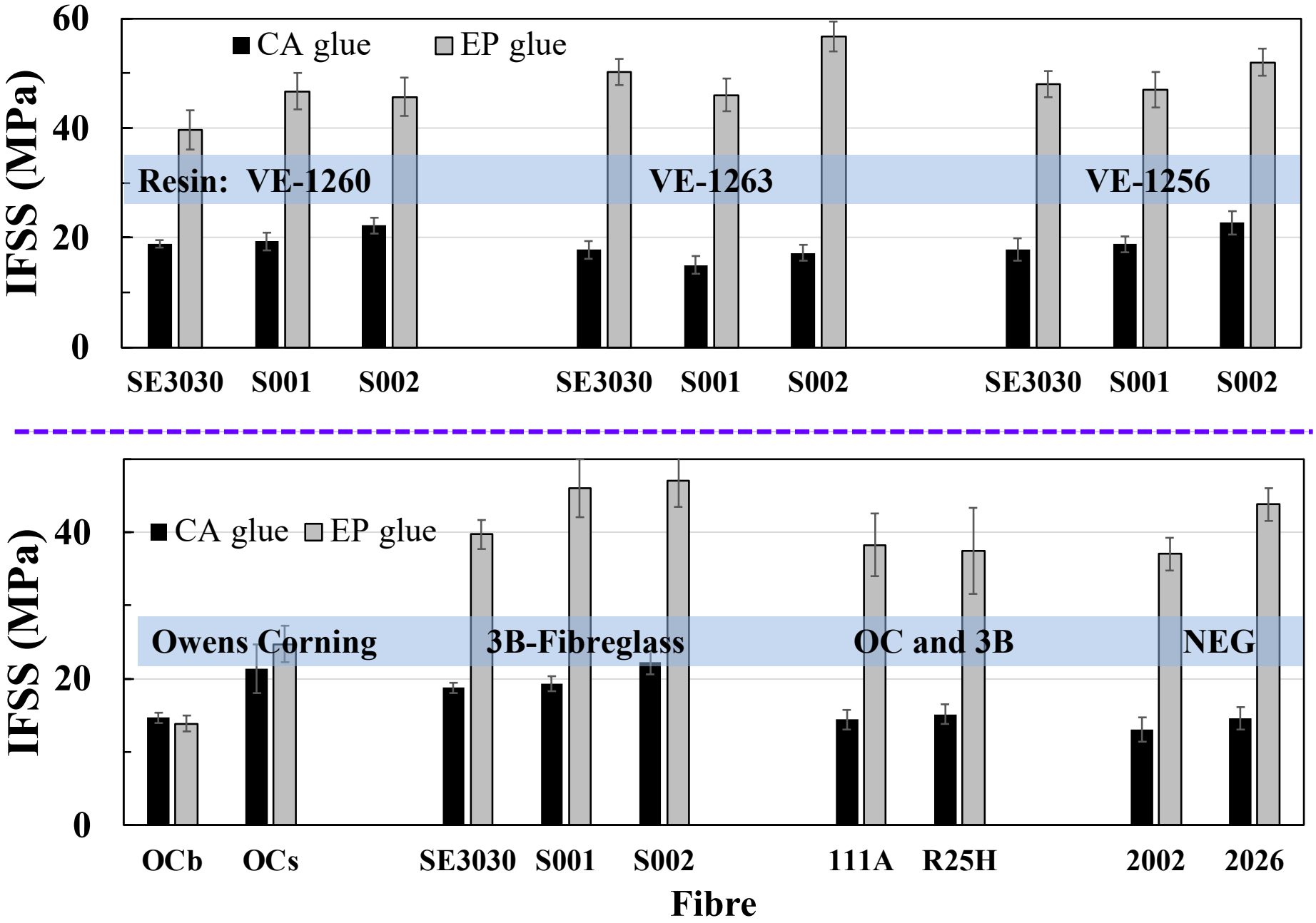
D Bryce, JL Thomason, L Yang, Thermoset Droplet Curing Performance in the Microbond Test, Submitted to Composite Interfaces 2023

VE Microdroplets vs Curing Atmosphere



JL Thomason, Polymer Testing 111 (2022) 107591.

Fibre Glue with VE Microdroplets



Some Conclusions

- **The Rubbish In, Rubbish Out concept definitely applies to microbond test specimens.**
- **There are many reasons why properties of microbond droplets may be different from expectations**
- **The examples given here are just some of the issues discovered so far – there are probably many more**
- **This does not mean the microbond test is "faulty"**
- **However, users of the test need to be aware of these potential pitfalls when assigning further meaning or interpretation to their results.**