Metathesis for the Synthesis and Repair of Materials

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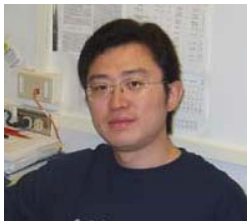
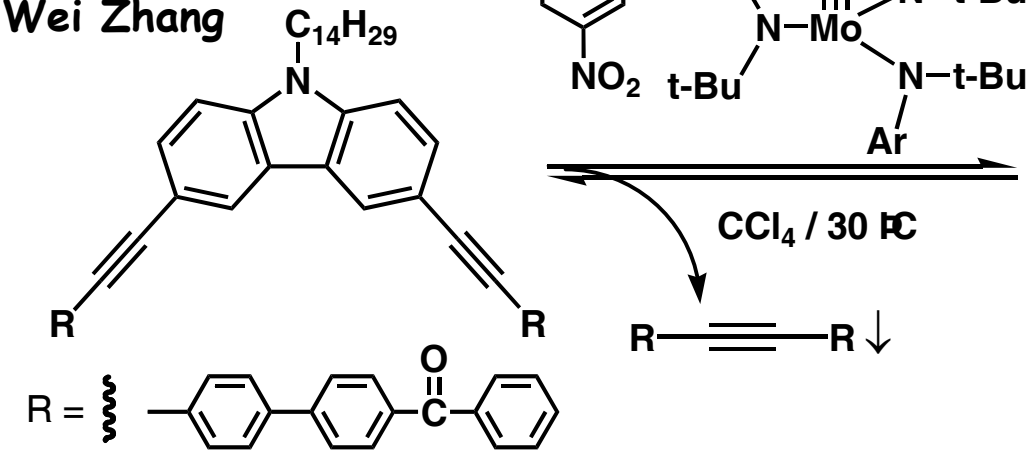
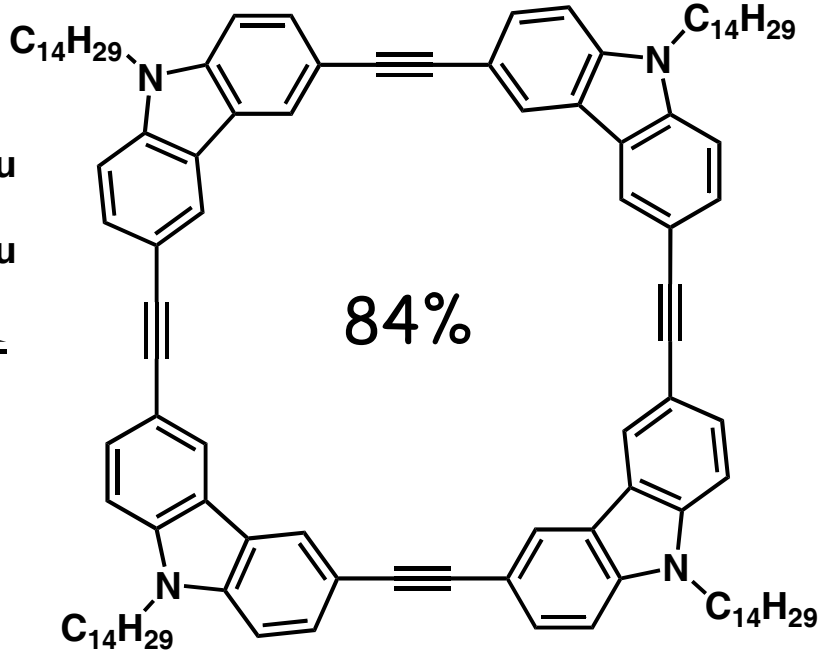
- Building blocks via cyclooligomerization
- Extending the lifetime of composite materials
- High temperature healing
- Repetitive healing

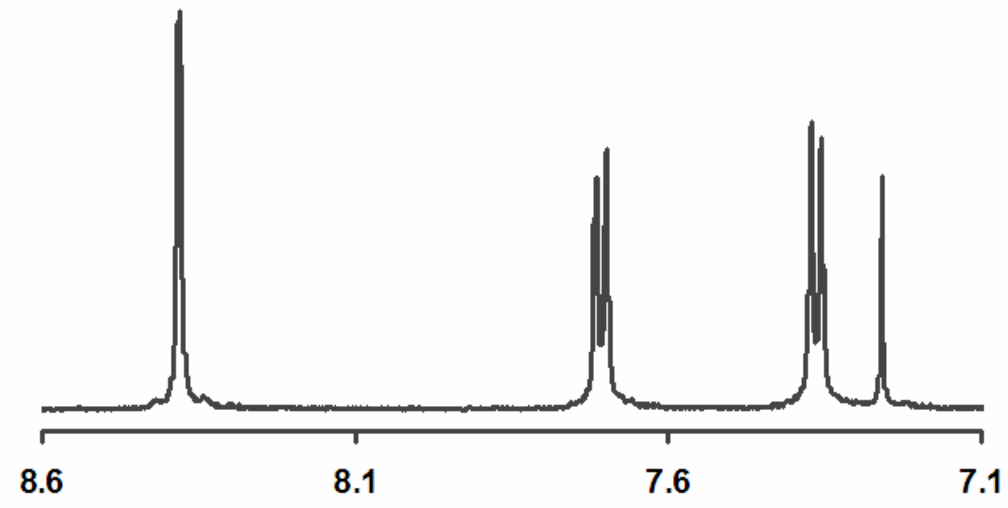
One-Step Cyclooligomerization via Alkyne Metathesis

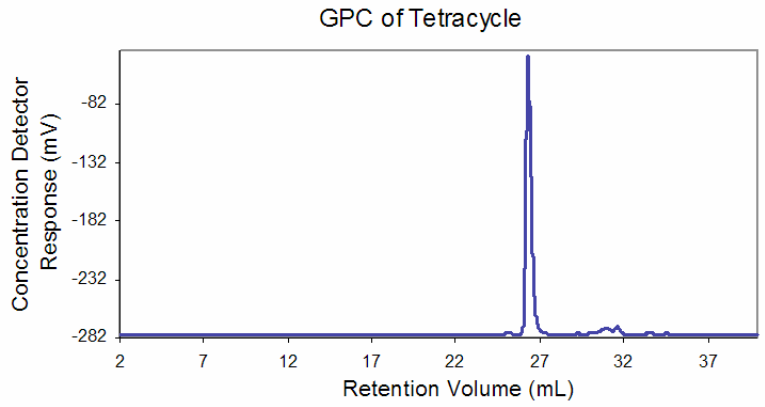


Wei Zhang



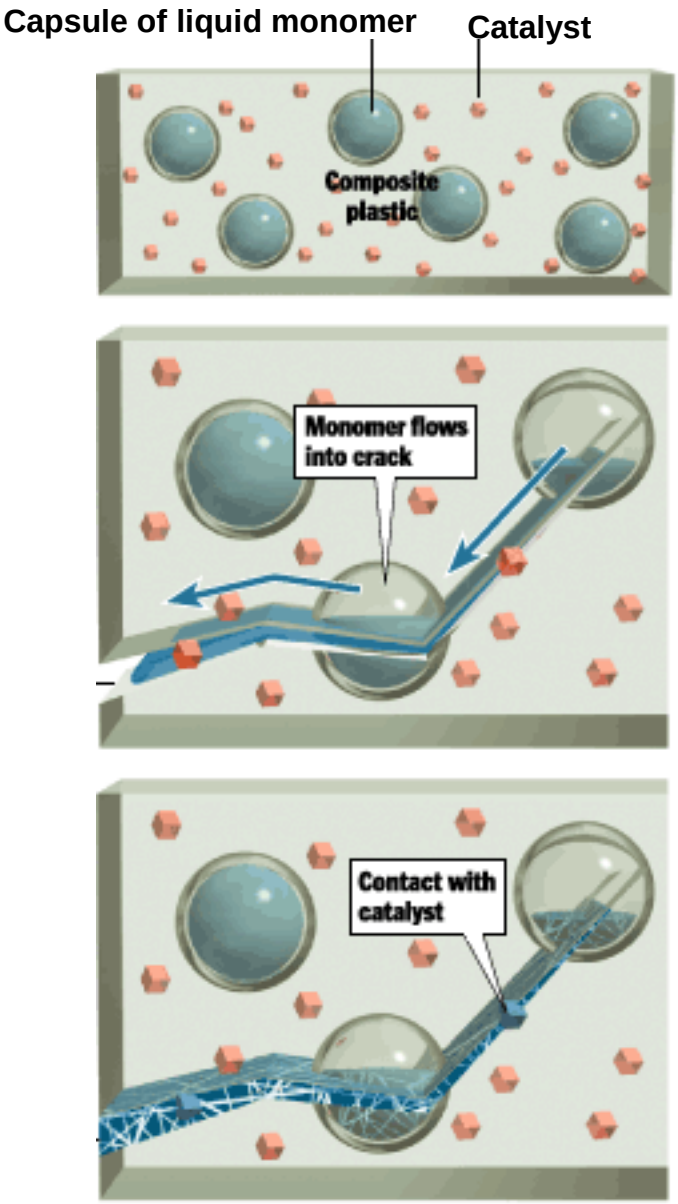






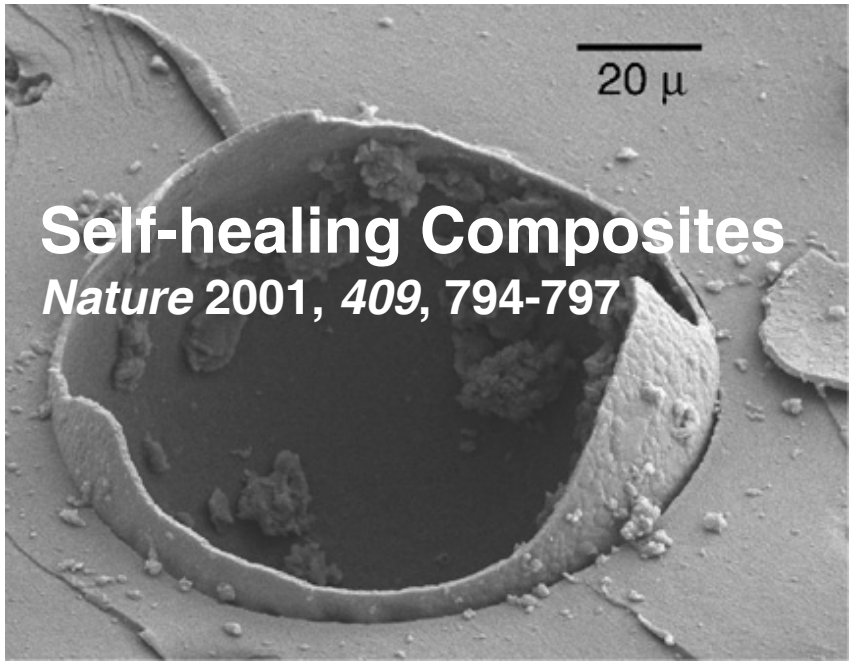
- Dynamic covalent approach
- Thermodynamic control

Compartmentalized Self-Healing Concept



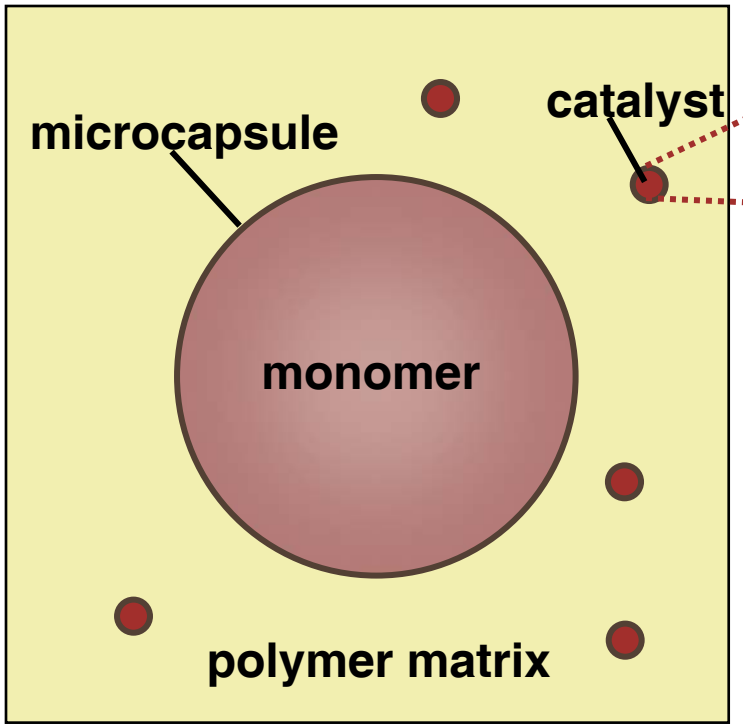
Self-Healing System

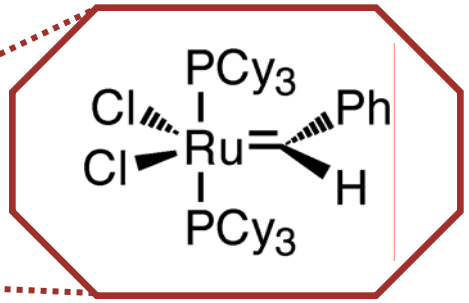
1) Storage
2) Rupture
3) Transport
4) Polymerization



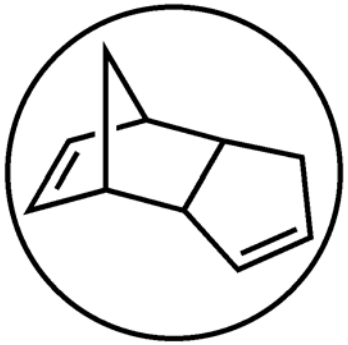
ROMP-Based Healing Chemistry

Component Materials



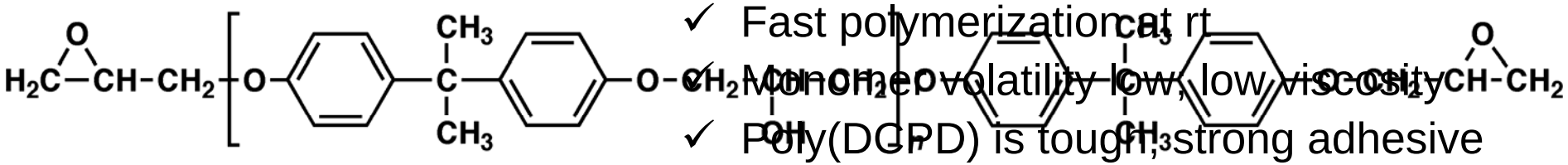


catalyst



monomer

diethylenetriamine (DETA)

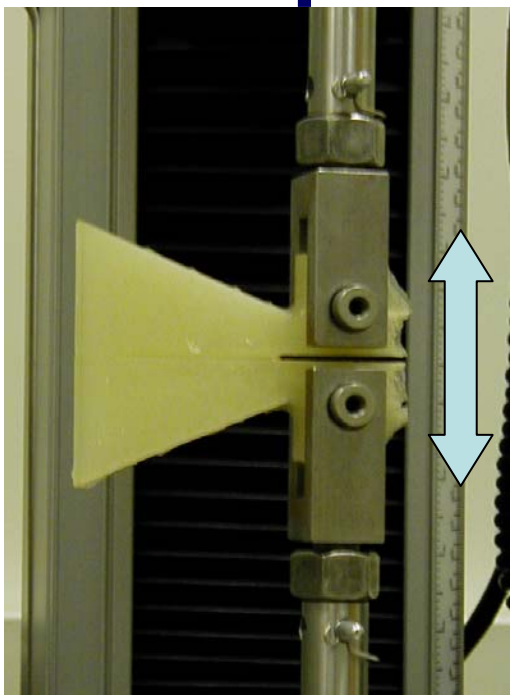


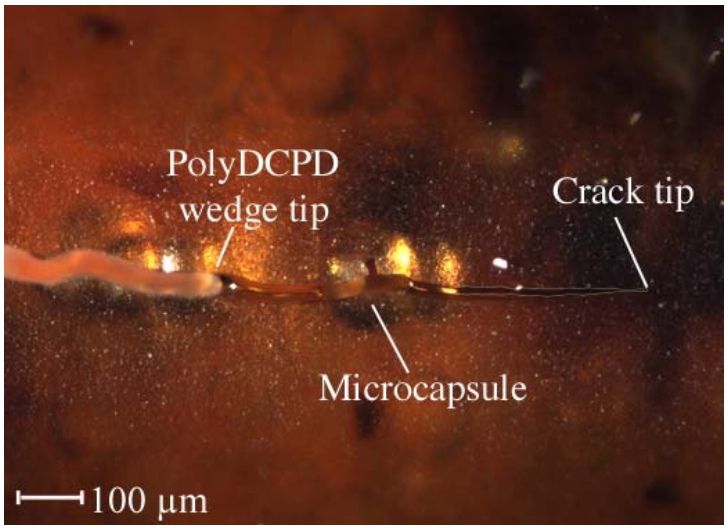
EPON 828

Why ROMP?

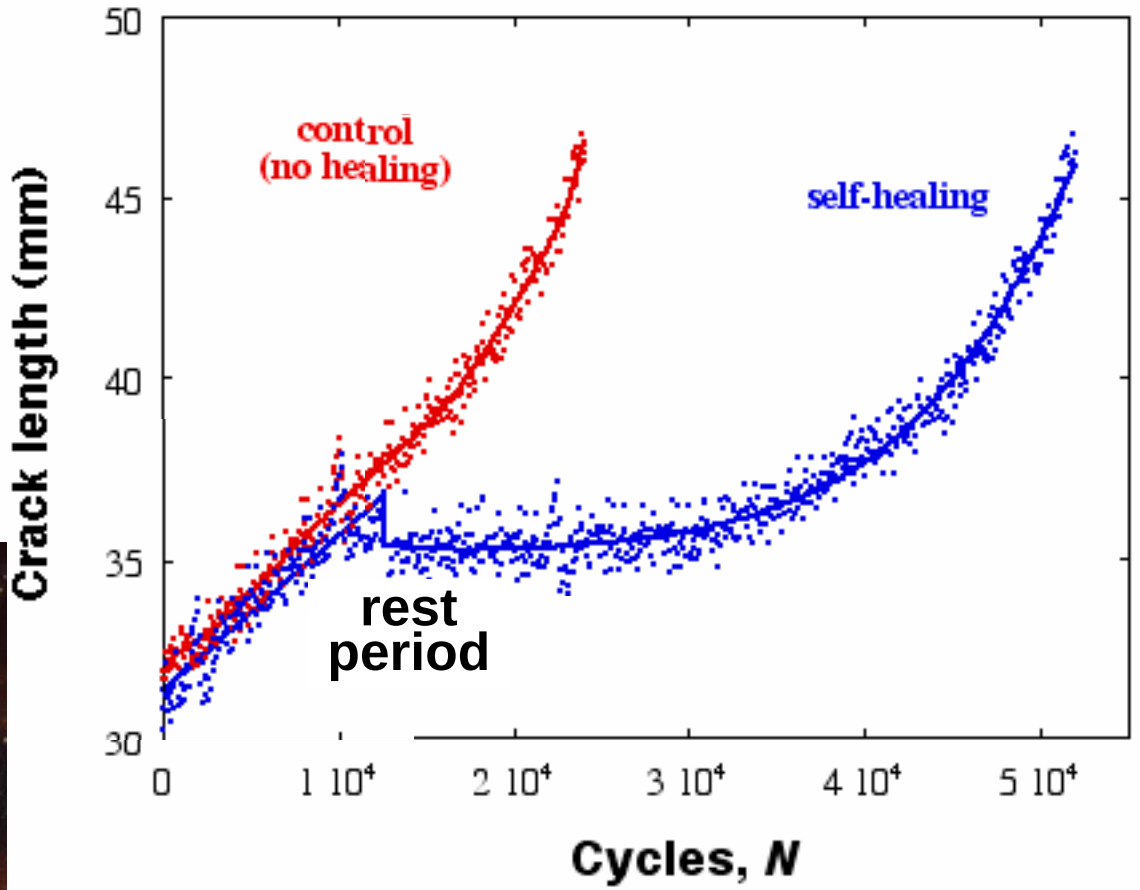
- ✓ ROP - small ΔV (monomer to polymer)
- ✓ Low monomer reactivity (w/out cat.)
- ✓ Fast polymerization at rt
- ✓ Monomer volatility low; low viscosity
- ✓ Poly(DCPD) is tough, strong adhesive
- ■ Catalyst stability / matrix compatibility

Extending Materials Lifetime by Improving Fatigue Performance





High K_{max} (fast crack growth rate)



K_{max} = 0.45 MPa $m^{1/2}$ R = 0.1, ω = 5 Hz

Summary

Catalyst morphology influences dissolution rates, thermal stability, and strongly impacts healing efficiency

Wax μsphere protection gives excellent healing with less catalysts due to better dispersion and stability

Freeze-dried samples are most reliable morphology, especially when protected with wax

2nd generation ROMP catalysts exhibit greater amine compatibility and enable healing at high temperature

Continuous healing is possible with microvascular composites

Function Through Metathesis Chemistry