Hybrid Polymer Biocomposites for Humidity Sensing

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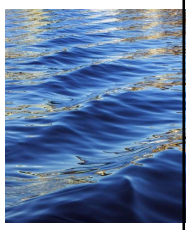


Outline

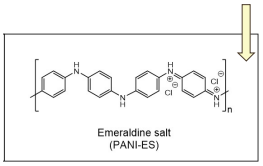
- Moisture-responsive materials
- Polymer composites for humidity sensing
- Measurements
- Results
- Conclusion

Moisture-Responsive Materials

Polyaniline (PANI)

- Intrinsically conductive polymer
- Composed of benzenoid (B) and quinoid (Q) units
- Precursor material for numerous electronic devices, including humidity sensors

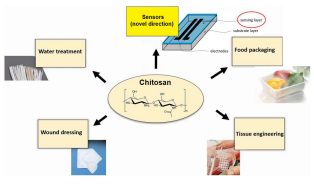
Conductive (H^+-doped)



Emeraldine salt (PANI-ES)

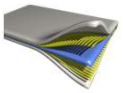
Chitosan (CHT)

- Hygroscopic biopolymer
- Composed of D-glucosamine **(deacetylated unit)** and N-acetyl-D-glucosamine **(acetylated unit)**
- Various areas of application; humidity sensing is a novel direction

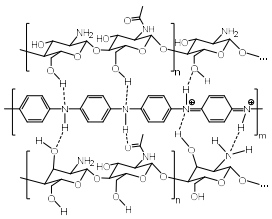


Polymer composites for humidity sensing

A ***composite material***, whose properties are different (unique) relative to that of single component materials



PANI/CHT binary composite



PANI/CHT moisture-responsive film

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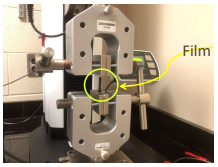
Measurements & Results

Mechanical testing, 4T sensing

Mechanical measurements

Tensile tester



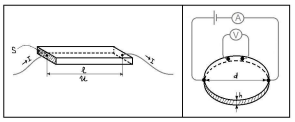
Force (F) vs elongation (Δl)

Stress [Pa]: $\sigma = \frac{F}{S}$

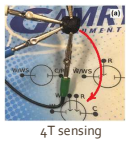
Strain [non-dimensional]: $\varepsilon = \frac{\Delta l}{l}$

Plot $\sigma = f(\varepsilon)$ and figure out ***stiffness*** as a slope

Electrical measurements



2T sensing (two-point probe) 4T sensing (four-point probe)



4T sensing

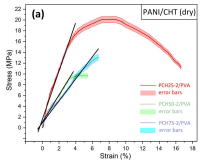
Resistivity

$\rho = \frac{US}{Il}$ $\rho = Rh$

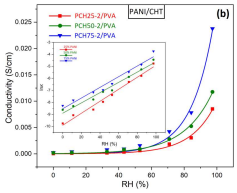
Conductivity $\sigma = \frac{1}{\rho}$

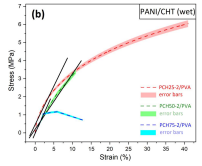
h – thickness of samples, 0.3 – 1.0 mm

Results



- 25% PANI: the highest stiffness, the highest ductility
- Suitable for humidity sensing





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~100x more conductive in wet state

	Sample	Conductivity (mS/cm)	
		dry	wet
PANI/CHT	25% PANI	0.058	8.5
	50% PANI	0.18	11.8
	75% PANI	0.25	24

Conclusion

- Remarkable mechanical properties for 25% PANI
- Remarkable sensing properties for 75% PANI
- PANI/CHT composites are promising sensor materials

Acknowledgement

Thank you for your attention!

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