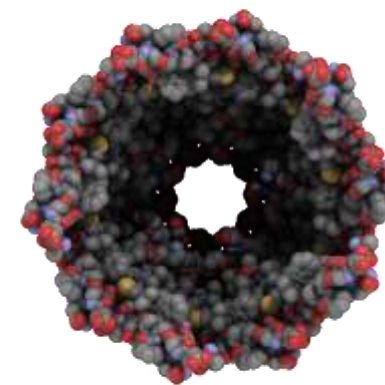
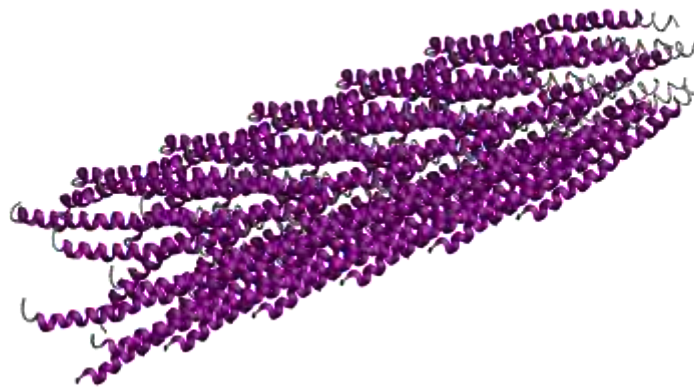
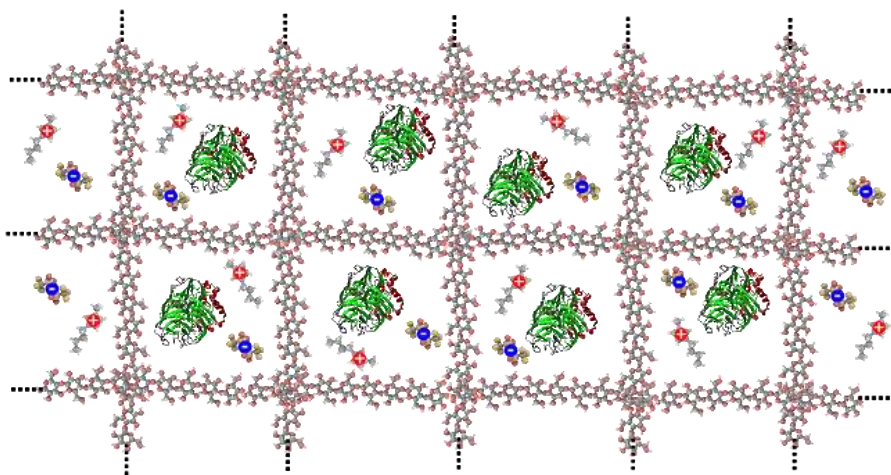


Expanding the design space of gel materials through ionic liquid mediated mechanical and structural tuneability



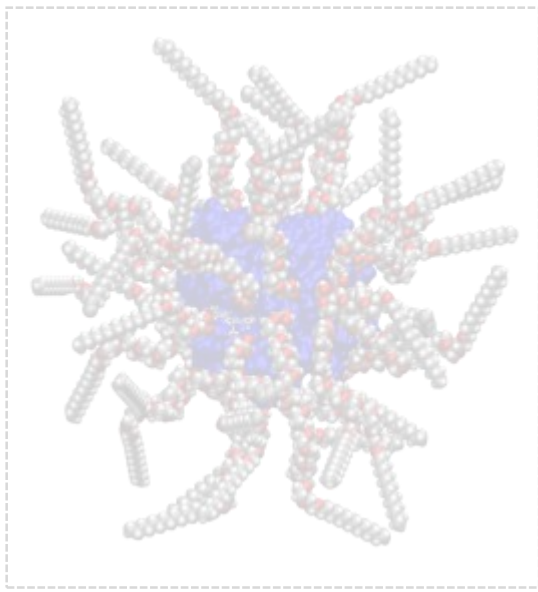
Dr. Alex P. S. Brogan
Department of Chemistry
 @apsbrogan

KING'S
College
LONDON

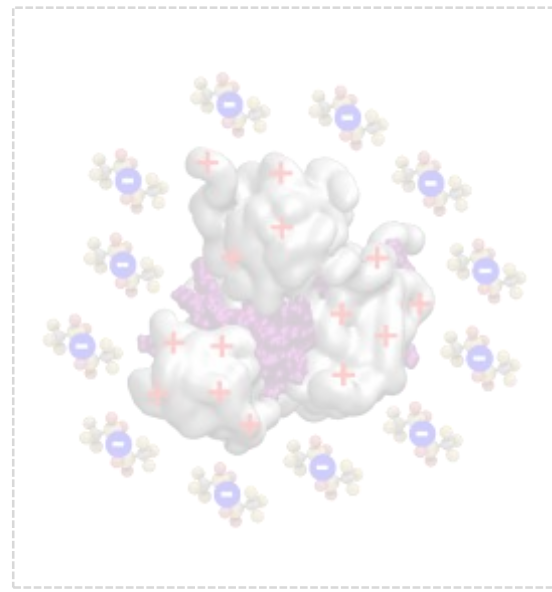
9th September 2019
RAMS 2019 - Liverpool
alexbrogan.co.uk/rams

Biomaterials in Brogan Group

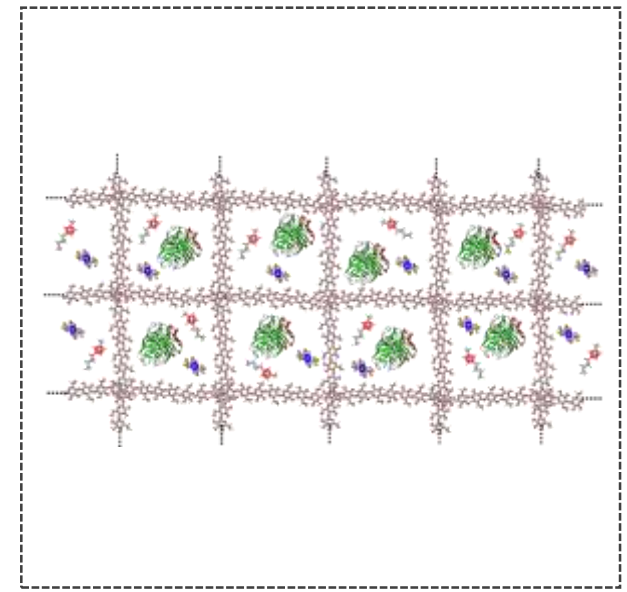
Solvent-free
Enzyme Biofluids



Ionic Liquid
Proteins



Ionogels

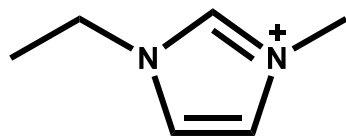


Ionic liquid based soft materials for biointerfacing



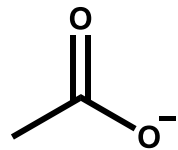
Ionic Liquids in Materials Design

Cation

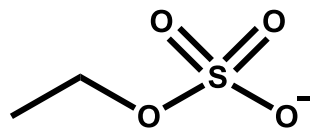


[emim]⁺

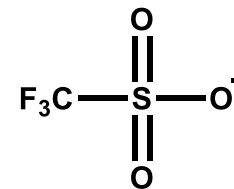
Anions



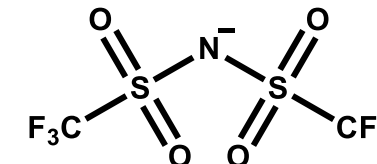
[OAc]⁻



[EtSO₄]⁻



[OTf]⁻



[NTf₂]⁻



- Ionic liquids are organic solvents with highly tuneable properties.
- Can solubilize and process otherwise recalcitrant polymers.
- High thermal stability, broad electrochemical window, and negligible vapour pressure.

→ **Relatively untapped potential in soft material design.**

Ionogel

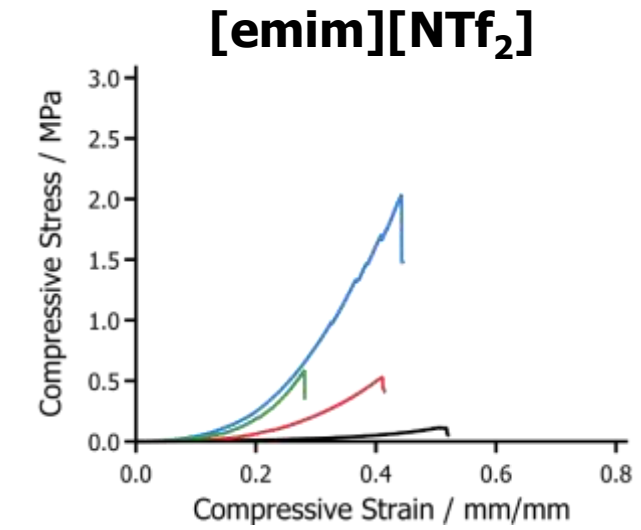
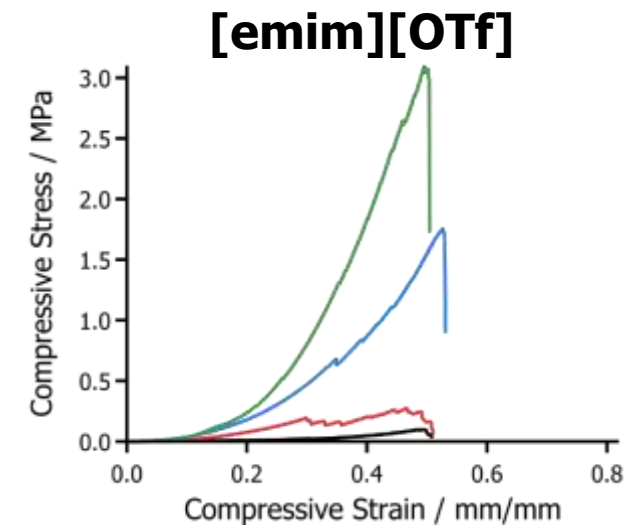
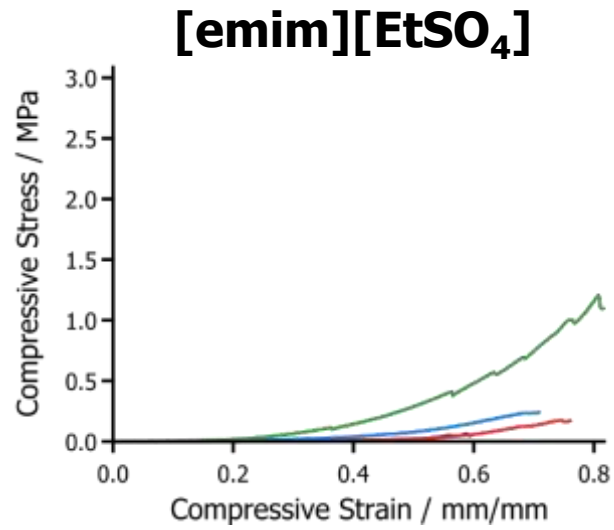
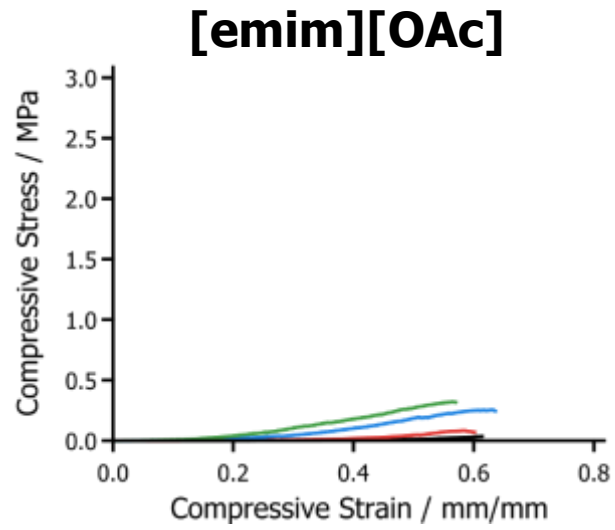
Hydrogel



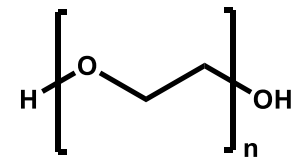
24 h



Ionogel Structure Property Relationship

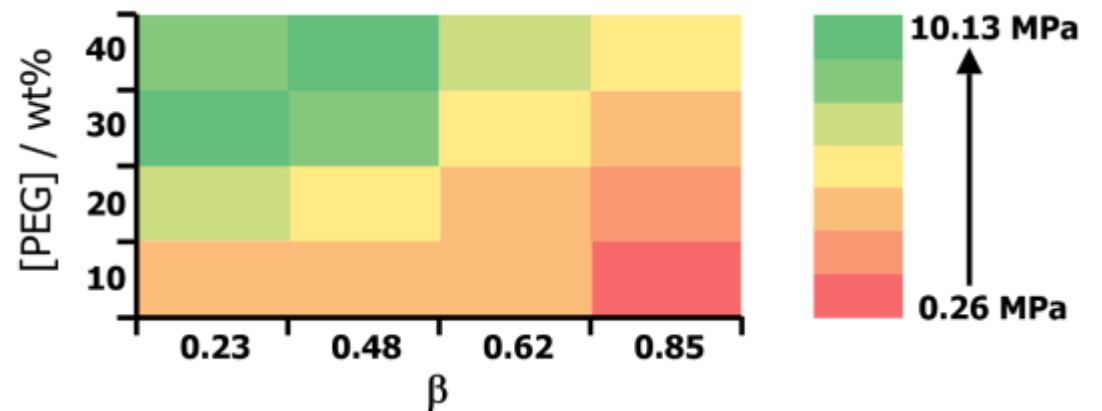


Poly(ethylene glycol) [PEG]

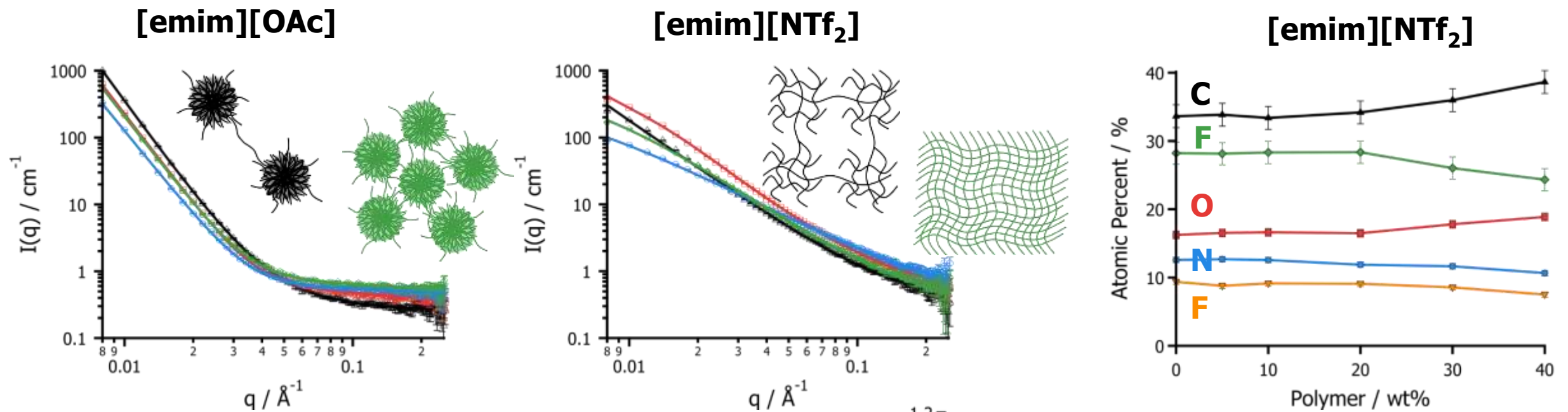


10 % 20 % 30 % 40 %

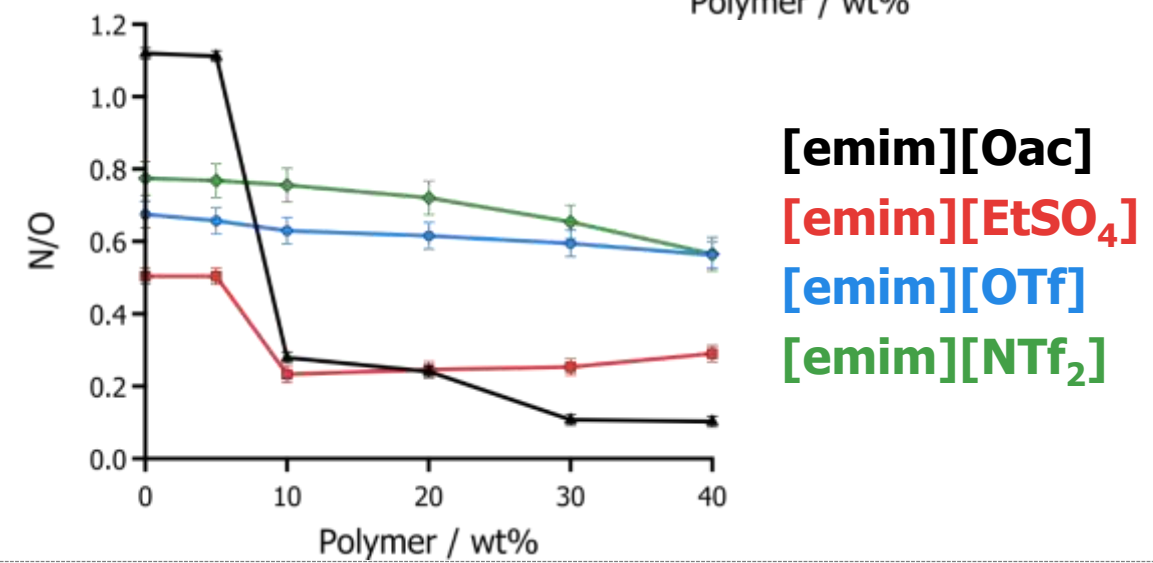
- Dependence of mechanical properties on ionic liquid anion.
- Decreasing polarity, increasing mechanical strength.
- Lower polarity, better solvent for polymer.



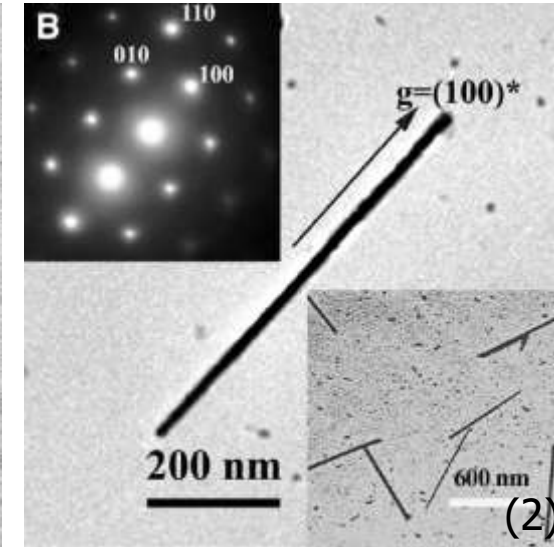
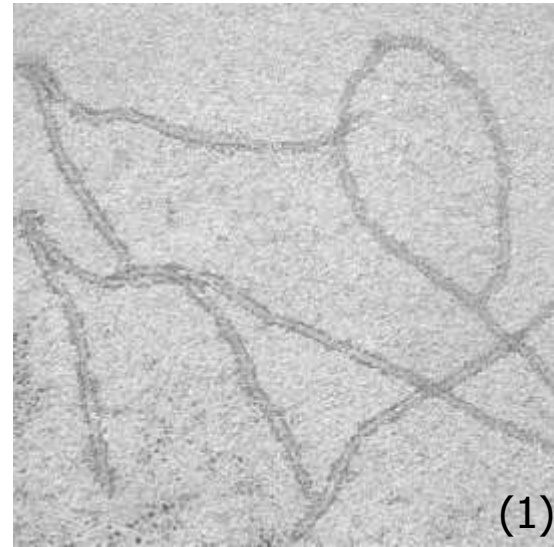
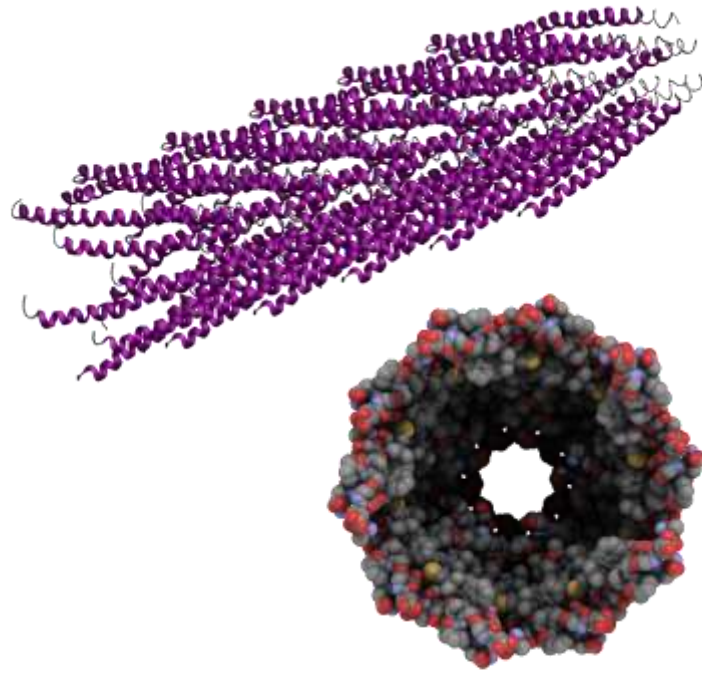
Ionogel Structure Property Relationship



- Polymer rich domains in poor solvents, to rigid networks in good solvents.
- XPS shows surface composition.
- Surface can also be controlled by ionic liquid.

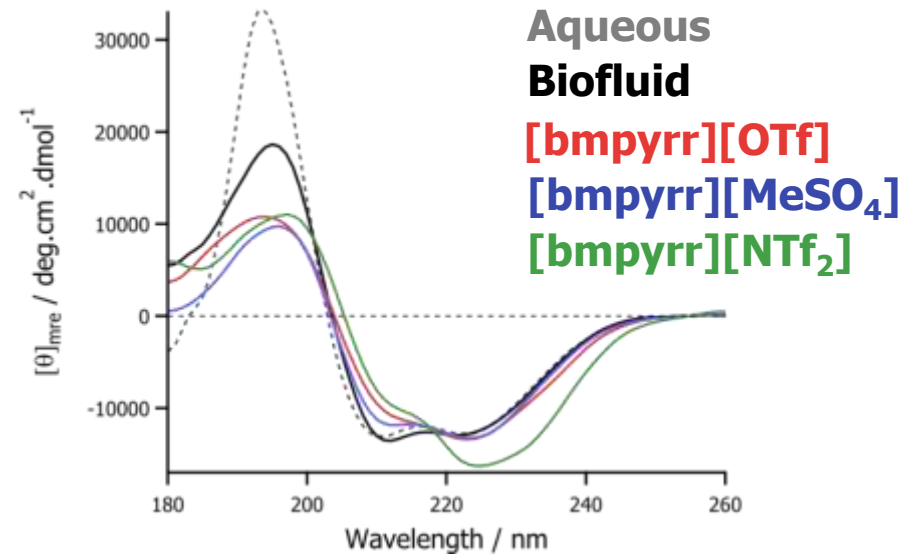
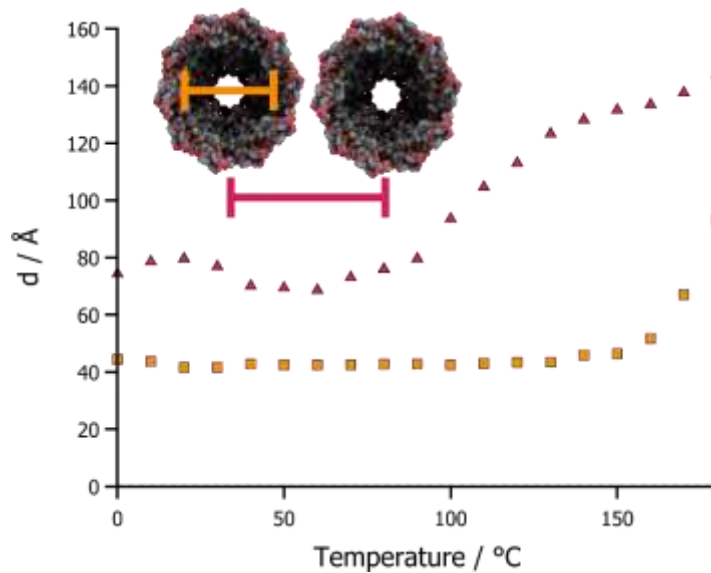
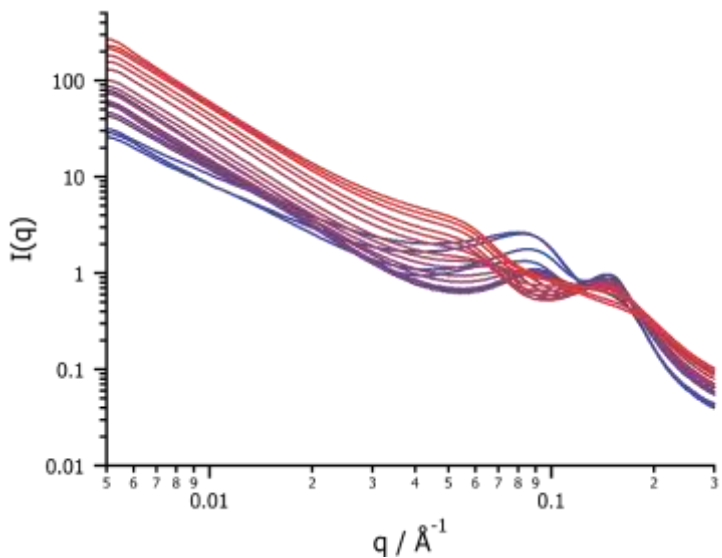


Filamentous Viruses as Functional Scaffolds for Ionogels

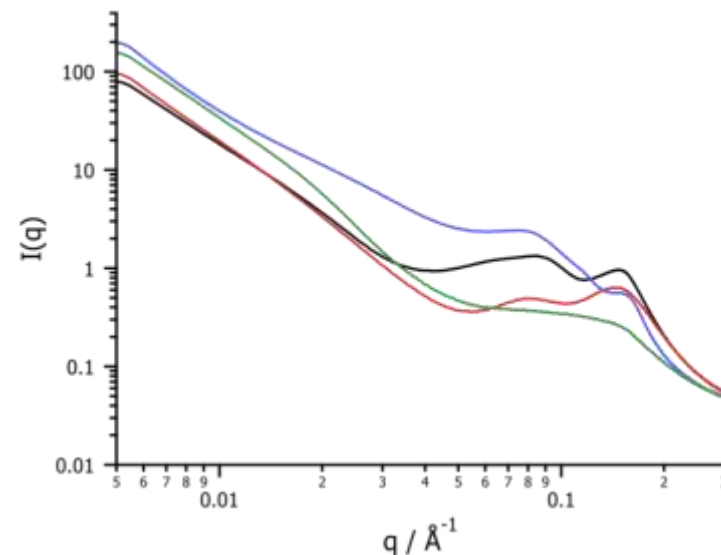


- M13 is a filamentous bacteriophage with extremely high aspect ratio – 10 nm wide by 900 nm long.
- Used by Belcher Lab (MIT) as highly versatile scaffold for templating various materials.
- Prospective uses as soft batteries and catalytic materials.

M13 Bacteriophage Biofluids and Ionic Liquids

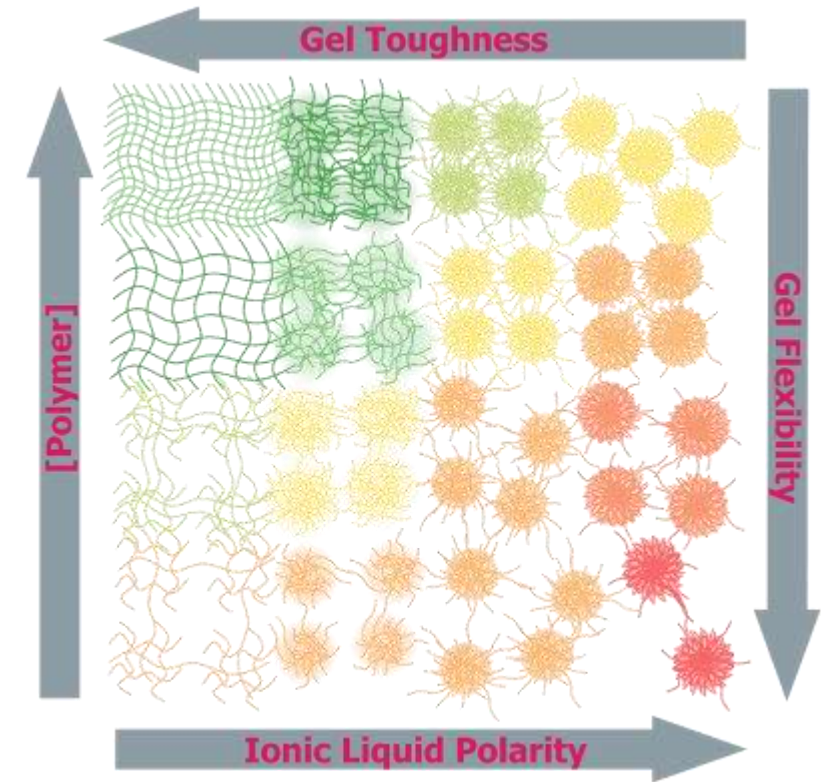


- Global architecture of M13 maintained up to 150 °C in solvent-free biofluid.
- Structure maintained in ionic liquids.
- Ionogels with phage incorporated can be made.



Conclusions

- Exciting new material with limited research on bio-interfacing.
- Ionogel mechanical properties dictated by ionic liquid anion as well as polymer concentration.
- Solvent-polymer solubility matching can provide additional level of tuneability for gel materials.
- M13 ionogels as platform for functional soft materials.
- Ionogels have great potential for designing new biomaterials.



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