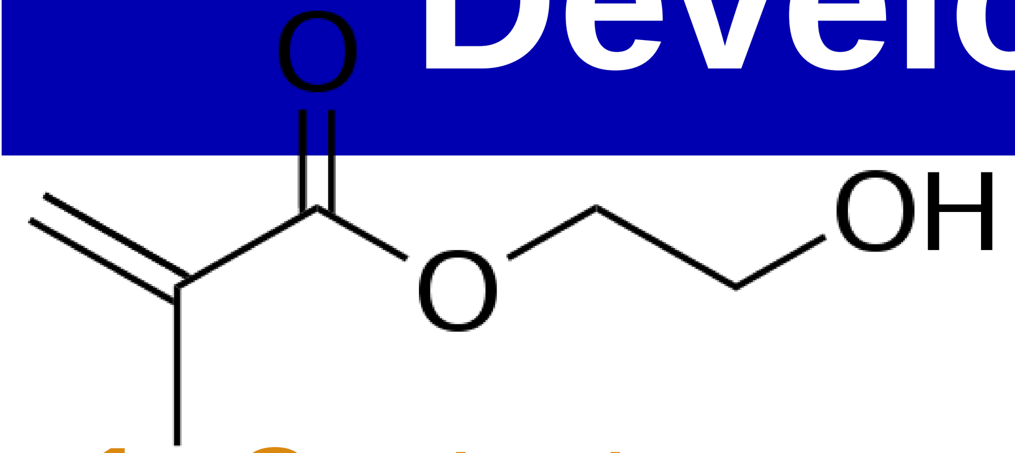
Developing Hydrogels for Medical Applications



| Kundan K. Jeswani*, 150272092, Chemical Engineering BEng Honours, k.jeswani1@ncl.ac.uk |
| Supervisor: Prof. Steve J. Bull | Newcastle School of Engineering |

1. Context

- Soft matter, such as **hydrogels**, can be used in several medical applications including drug delivery, contact lenses and tissue engineering[1].
- Hydrogels are hydrophilic polymer networks which are able to absorb large amounts of water. Due to their structure, hydrogels have different physical properties with different swelling ratios.

2. Aims and objectives

- To determine how existing commercial hydrogels can be modified to improve their functionality.
- To develop a more reliable method of applying the surface speckle pattern needed for Digital Image Correlation (**DIC**) strain analysis.

3. Methodology

- Hydrogels were prepared using the monomer HEMA (Fig. 1). Samples of 0.5%, 1.0% and 2.0% crosslinker concentrations were created by varying the quantity of **crosslinker** EGDMA[2].
- Each sample was further developed with different free volumes (holes):
  - ➢ Sample A: 0% free volume (plain)
  - ➢ Sample B: 27% free volume
  - ➢ Sample C: 44% free volume

  (Note that samples B had bigger holes than samples C).
- A tensile testing frame (Fig. 2) was used to calculate the Young's modulus (**stiffness**) and ultimate tensile strength (**UTS**) of the samples.
- The tensile test recordings were uploaded to DIC software and analysed to obtain axial and lateral strain maps (Fig. 3).

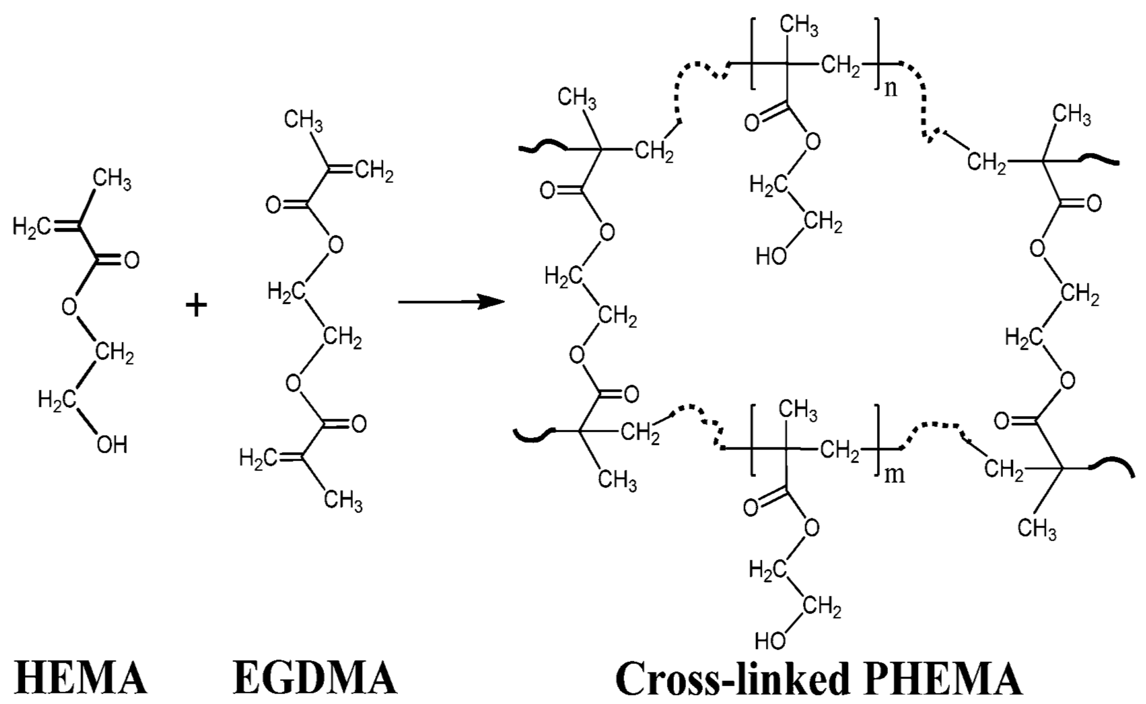


Fig. 1 Chemical synthesis

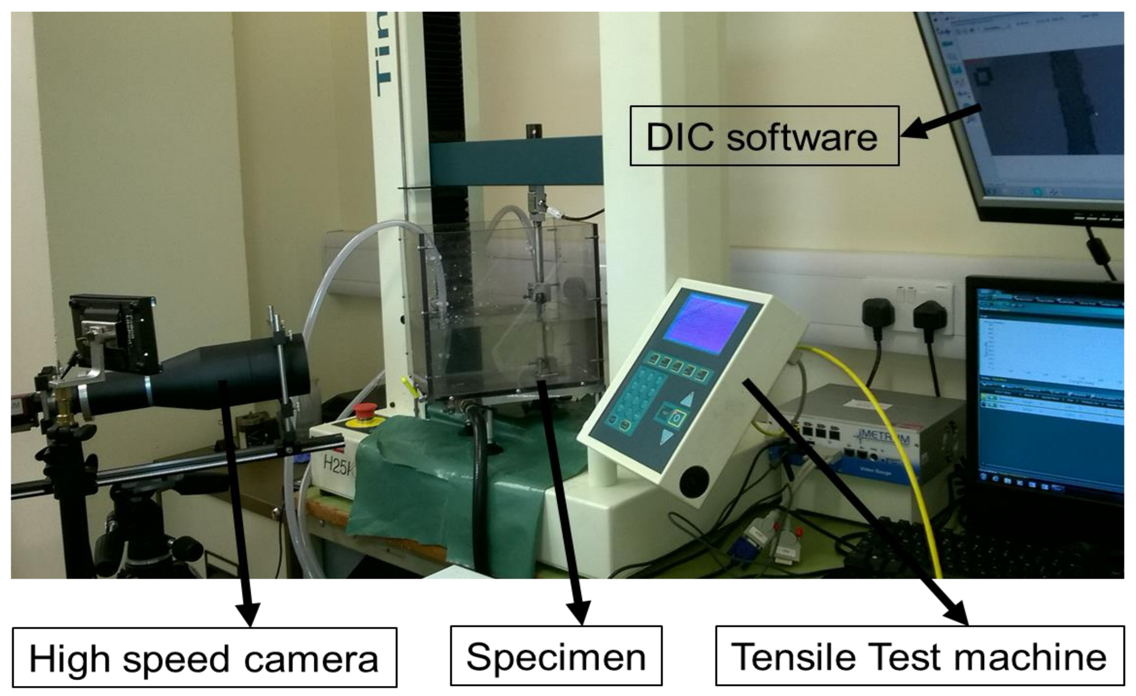


Fig. 2 Experimental set-up

4. Results

- The UTS of the samples didn't depend on the free volume of the gels but instead on the **size** of the holes in the physical structure. Fig. 3 shows that Sample B (right) had a greater proportion of large stresses than sample C (left).
- Fig. 4 displays that the **UTS of pHEMA hydrogel increases with the quantity of crosslinker.** It indicates that increasing the amount of crosslinker results in an increase in the strength of the polymer chains.
- Samples B had higher stiffness constants than Samples C (Fig. 5). This shows that as free volume increases the flexibility of the material also increases.

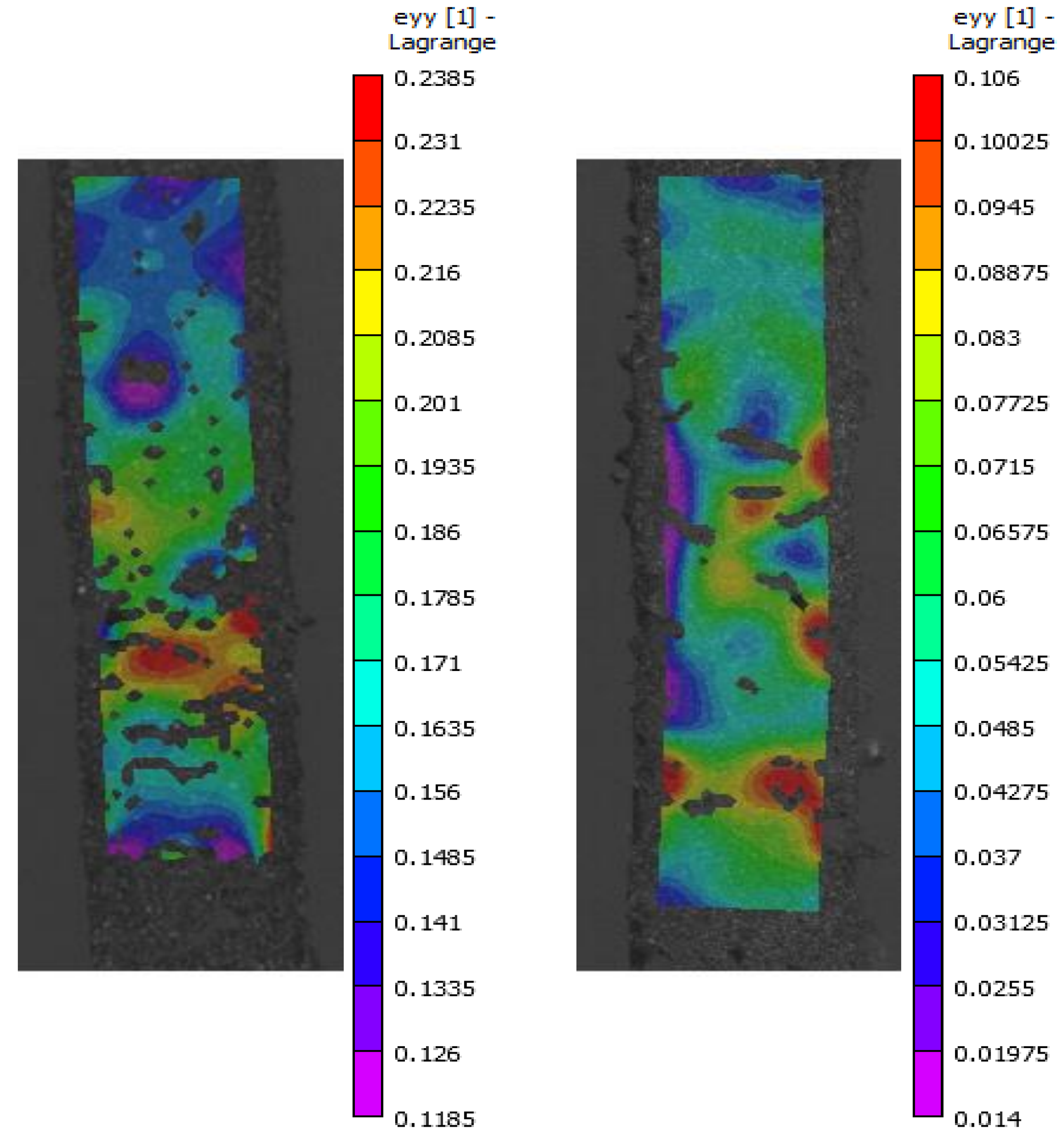


Fig. 3 Images of axial strain obtained using DIC software for sample C (left) and sample B (right) of 1% crosslinker

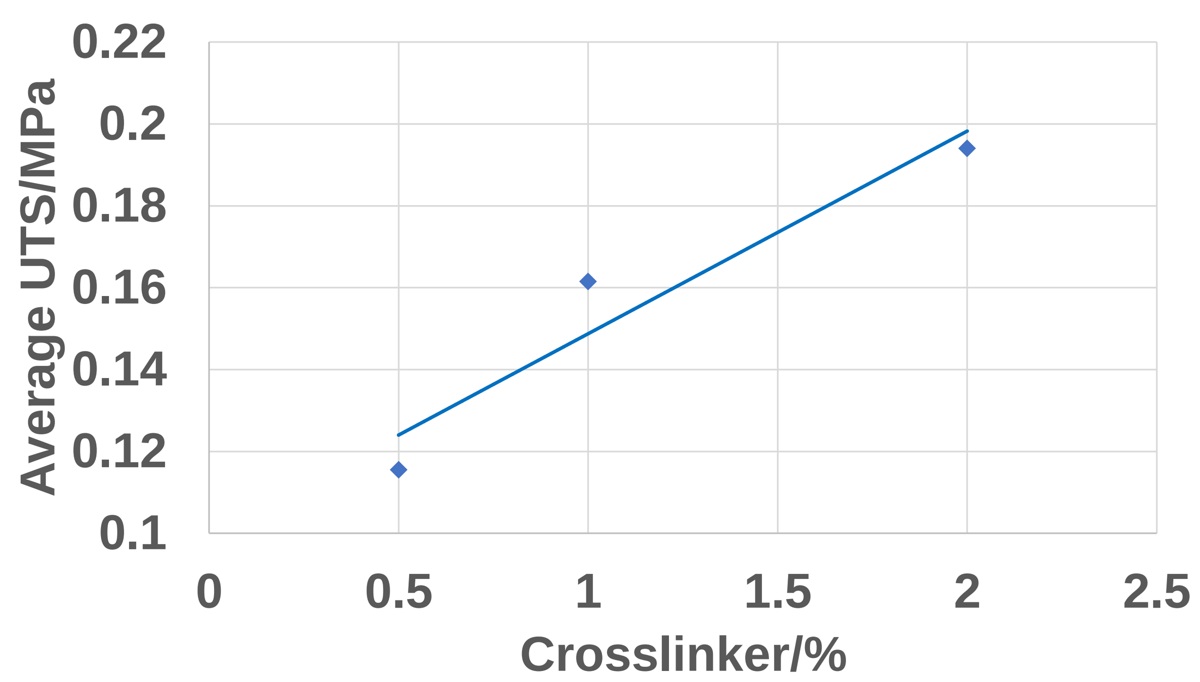


Fig. 4 Sample A UTS vs. crosslinker

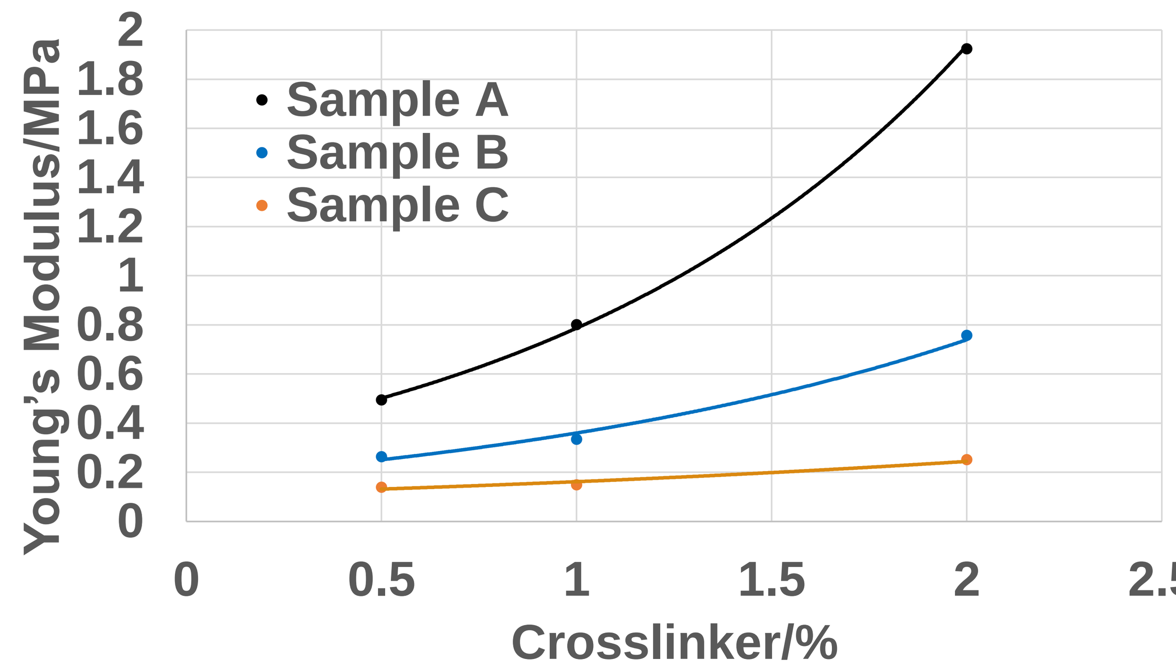


Fig. 5 Young's modulus with variation in crosslinker concentration and free volume

5. Conclusion

- Stronger hydrogels can be developed by increasing the amount of crosslinker. This is particularly useful for contact lenses.
- The new speckle pattern was detected by the DIC software successfully. This **reliable method** can now be used to create both axial and lateral strain maps of specimens.

References: 1. Ahmed, E. (2015). Hydrogel: Preparation, characterization, and applications: A review. *Journal of Advanced Research*, 6(2), pp.105-121
2. Maitra, J. and Shukla, V. (2014). Cross-linking in Hydrogels - A Review. American Journal of Polymer Science, [online] 4(2), pp.25-31.

Newcastle University