3D-printing of drug loaded hydrogel inks – Relating rheology to printability

Oliver Etzold[a]
Robert H. Aguirresarobe[b], José M. Asua[a] and Marcelo Calderón[a,c]

(a) POLYMAT and Applied Chemistry Department, Faculty of Chemistry, University of the Basque Country UPV/EHU, Paseo Manuel de Lardizabal 3, 20018 Donostia – San Sebastián, SPAIN
(b) POLYMAT and Polymer Science and Technology Department, Faculty of Chemistry, University of the Basque Country UPV/EHU, Paseo Manuel de Lardizabal 3, 20018 Donostia – San Sebastián, SPAIN
(c) IKERBASQUE. Basque Foundation for Science, Maria Diaz de Haro 3, 48013 Bilbao, SPAIN

Oliver.Etzold@polymat.eu

For the last couple of decades, hydrogels have gained a lot of significance in pharmaceutical applications. Nowadays, myriad materials are known to form hydrogels with applications including drug and gene delivery, tissue engineering and cell therapy.[1, 2] In drug delivery, 3D printing provides spatial precision and thus potential control of the release profiles for the delivery of multiple drugs.[2, 3] The resolution in this context is a key parameter as it determines the final drug concentration. A good control over the whole process is therefore necessary and rheology appears a valuable tool to predict the material performance.

The present study investigated how a mixture of FDA-approved poly(ethylene glycol) (PEG) and carboxymethyl cellulose (CMC) is influenced by the concentration of its constituents in terms of rheological behaviour. Additionally, it was shown how the incorporation of clinically relevant amounts of drug has further influence thereon. Based upon their rheological behaviour, the printability of those mixtures by extrusion 3D-printing was assessed (*Fig. 1*). Key parameters in rheological behaviour were identified to predict the printability. Finally, this study sought to influence those key parameters due to chemical reasoning.

The authors kindly acknowledge the funding of this study by the Basque government *via* the ELKARTEK (KK-2019/00048) program.

References

[1] N. Annabi et al., Advanced Materials, 26 (2014) 85.
[2] S. J. Buwalda, T. Vermonden, W. E. Hennink, Biomacromolecules, 18 (2017) 316.
[3] S. J. Buwalda et al., Journal of Controlled Release, 190 (2014) 254.

Figures

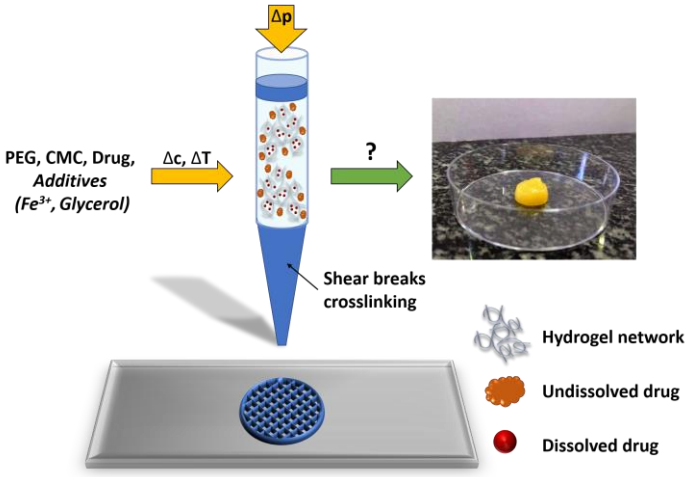

Figure 1: Schematic representation of the study. Rheological behaviour of drug-loaded CMC-PEG mixtures is screened with respect to material composition and printing conditions (*yellow arrows*). Based on those results, the printability is related to key rheological parameters (*green arrow*).