Forces and Interfaces: Structural damage to biomolecules during droplet generation

Susannah Evans

University of Cambridge, UK

Precise and reliable microdroplet generation is highly desirable for studying solutions containing biological materials such as cells and enzymes, for continuous manufacturing and late-stage customisation of pharmaceuticals [1]. Inkjet printing is one technology capable of handling fluids in such a manner but during the printing process these, often delicate, molecules are frequently impaired and are seen to lose activity. However the precise mechanism of this damage is poorly understood. A previous study demonstrated loss of activity up to 70% when printing HRP with losses experienced once compression rates exceed 2.5$\mu m^3/\mu s$ [2]. This research examines how the shear and extensional forces and changing interfaces experienced by the biological ink throughout the printing process impact on the retained activity of the biomolecules, Horse Radish Peroxidase (HRP), Glucose Oxidase (GOx) and Sarcosine Oxidase (SOx).

It is anticipated that through a better understanding of the damage caused to proteins during the inkjet printing process, the technology can be more easily translated into large-scale bio-printing and as interest in using bio-macromolecules as drug candidates has increased due to their favourable properties, which include fewer side effects and higher efficacy than small molecule drugs, this research demonstrates a clear application within the pharmaceuticals industry.

[1] R. Daly, T. S. Harrington, G. D. Martin, and I. M. Hutchings, “Inkjet printing for pharmaceutics - A review of research and manufacturing,” Int. J. Pharm., 2015.
[2] G. M. Nishioka, A. A. Markey, and C. K. Holloway, “Protein damage in drop-on-demand printers,” J. Am. Chem. Soc., vol. 126, no. 50, pp. 16320–16321, 2004.