Chemo-mechanics of biodegradable polymers

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KEYWORDS: *Hydrolysis, Reaction, Diffusion, Viscoplasticity, Constitutive modelling.*

Biodegradable polymers are materials designed to degrade and ultimately disappear after having completed their structural function. They are increasingly developed for engineering and biomedical applications, where simultaneous control over mechanical performance and degradation behaviour is critical. Many biodegradable polymers primarily degrade via hydrolysis, in which water molecules react with susceptible backbone bonds (e.g. esters), leading to chain scission. Chain scission in turn impacts the thermo-mechanical properties and causes mass loss. Conversely, mechanical stress can also impact the degradation kinetics [1].

In this talk, I will describe our recent experimental and modelling efforts to investigate the coupled chemo-mechanical behaviour of various degradable polymer systems in aqueous environments, including glassy polymers, semi-crystalline polymers, and biodegradable hydrogels. In particular, I will present a constitutive modelling framework for amorphous polymers, incorporating a mechanistic description of the chain scission process and its influence on the elasto-viscoplastic behaviour through the concept of effective temperature [2, 3]. We show that the behaviour of wet, degraded polymer can be accurately captured by evaluating the response of the dry, undegraded polymer evaluated at an elevated temperature and reflecting the reduction in glass transition temperature due to chain scission and water uptake.

ACKNOWLEDGEMENT: This research is supported by a Future Leaders Fellowship of UK Research and Innovation (MR/W006995/1).

[1] H. Chen, Z. Pan, G.S. Sulley, C.K. Williams, L. Brassart, *Polym. Degrad. Stab.* **243**, 111751, 2026. https://doi.org/10.1016/j.polymdegradstab.2025.111751

[2] Z. Pan, L. Brassart, *Acta Biomater.* **167**, 361–373, 2023. https://doi.org/10.1016/j.actbio.2023.06.021

[3] Z. Pan, H. Chen, L. Brassart, *Int. J. Plasticity* **178**, 103996, 2024. https://doi.org/10.1016/j.ijplas.2024.103996