Bespoke Photodynamic Polymer for Antibiotic-free Infection Control

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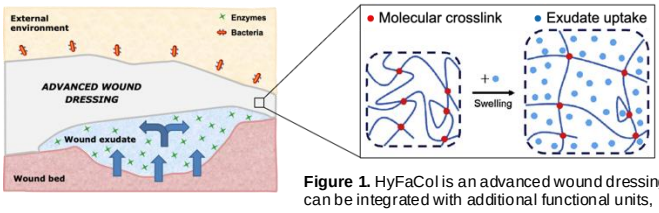
Background

- Chronic wounds, e.g. diabetic ulcers, fail to heal through an orderly and timely self-healing process, causing pain, mobility challenges, and significant risks of gangrene and amputation [1].
- Antibiotic resistance and currently available antibiotic-free antimicrobial strategies generate risks of recurrent infection, long hospitalization, and significantly higher treatment costs [2].
- HYFACOL is a University of Leeds spin-out company that is developing an advanced wound dressing (HyFaCol) with superior wound healing capability and integrated antimicrobial photodynamic capability.

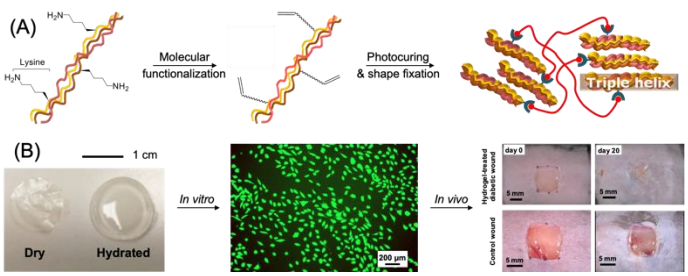
HyFaCol – the purest collagen-based wound dressing



- Mechanical integrity *in situ*
- Drug-free inhibition of matrix metalloproteinases (MMPs)
- Integrability with an antimicrobial photodynamic polymer

Figure 1. HyFaCol is an advanced wound dressing made of functionalized collagen molecules, which can be integrated with additional functional units, including an antimicrobial photodynamic polymer.

Development & preclinical testing of HyFaCol



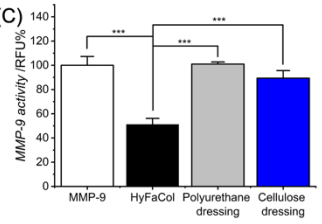
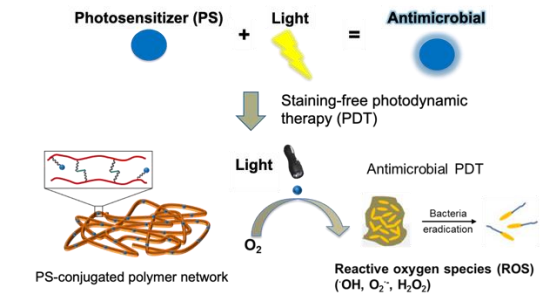


Figure 2. Molecular design (A), testing *in vitro* and *in vivo* (B) and drug-free inhibition of MMP-9 (C; n=4, *** $p < 0.001$).

Design of a bespoke photodynamic polymer with light-induced antimicrobial capability



- Antibiotic-free antimicrobial polymer
- Fibre-forming, photocurable

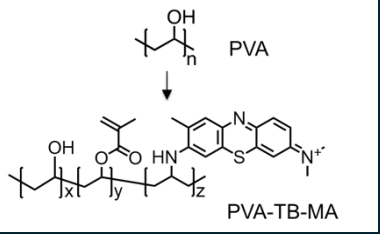


Figure 3. A polyvinyl alcohol derivative (PVA-TB-MA) has been developed to achieve antimicrobial photodynamic effect. Grafting of toluidine blue (TB) minimizes risks of PS diffusion and staining, while PVA methacrylation enables integrability with wound dressings, including HyFaCol.

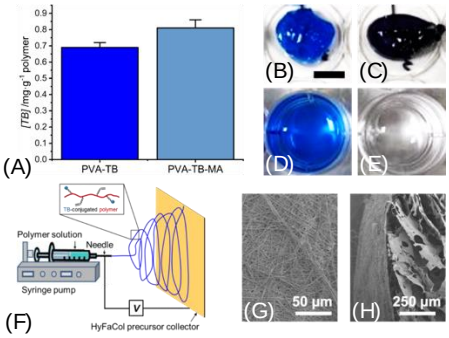


Figure 4. (A): Quantification of TB grafting via UV-Vis spectroscopy. (B-E): Photographs of a UV-cured PVA network (B), a TB-loaded variant (C) and respected supernatants (D-E) following 96-hour incubation *in vitro*. Scale bar: 5 mm. (F-H): Polymer integrability with HyFaCol via electrospinning (F). Electron microscopy of top (G) and cross-section (H) surface.

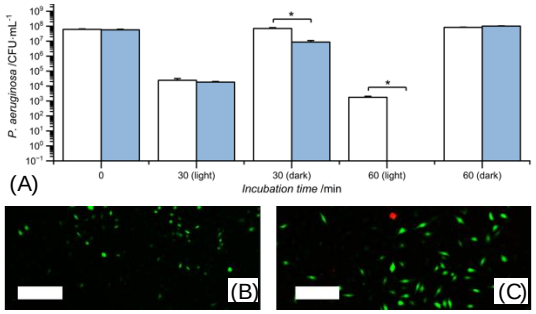


Figure 5. (A): Antibacterial photodynamic testing of the UV-cured PVA network with *P. aeruginosa* (n=3, *$p < 0.05$). (B-C): Live-dead images of L929 murine fibroblasts following 24-hour culture with the culture medium control (B) and the UV-cured polymer extract (C). Scale bars: 200 µm.

References

[1] G. Tronci, S.J. Russell, D.J. Wood et al. *J. Mater. Chem. B* 2016 (4) 7249

[2] M. Li. C. Brooker, G. Tronci et al. *Eur. Polym. J.* 2025 (228) 113704