Photocrosslinkable Polymers for Tissue Regeneration

Xin Zhao

11 Yuk Choi Road, Hung Hom,
The Hong Kong Polytechnic University
Hong Kong, Hong Kong SAR China
xin.zhao@polyu.edu.hk

Photocrosslinkable polymers are polymers that can be solidified from liquid upon light exposure. They have been employed to fabricate tissue engineered constructs due to the mild conditions for crosslinking, highly tunable mechanical and structural modifiability, printability, biodegradability and biocompatibility. These biomaterials can maintain their structural integrity after biofabrication and provide topological, biochemical, and physical cues to guide cellular behaviors by creating a biomimetic microenvironment.

The emphasis of this talk is placed on how photocrosslinkable polymers can be used to achieve regeneration of diseased or damaged tissues, for example, their fabrication into various scaffolds (electrospun fibers, microspheres, and 3D printed scaffolds) to reconstruct hard tissues like bone as well as soft tissues such as skin (Figure 1). Specifically, assisted by microfluidics, we have developed photocrosslinkable methacrylated gelatin (GelMA) based microspheres encapsulating human mesenchymal stem cells (MSCs) for bone repair[1]. Due to the mild crosslinking conditions, we found that the GelMA microspheres can provide a favourable micro-environment for MSC survival, spreading, migration, proliferation and osteogenesis. In another study, we prepared a periosteum mimicking bone aid (PMBA) by electrospinning photocrosslinkable GelMA with L-arginine-based unsaturated poly(ester amide) (Arg-UPEA), and methacrylated hydroxyapatite nanoparticles (nHAMA)[2]. Upon light exposure, the resultant hydrogel fibrous scaffolds can solidify within seconds. Via controlling the crosslinking density, we can control the scaffolds' mechanical and degradation property. Additionally, the optimal scaffold was found to provide long-term structural and functional support and mediation of physiological activity. With the aid of 3D printing, we developed 3D bone scaffolds made of photocrosslinkable nanocomposite ink consisting of tri-block poly (lactide-co-propylene glycol-co-lactide) dimethacrylate (P_mL_nDMA, m and n respectively represent the unit length of propylene glycol and lactide) and nHAMA[3]. It is discovered that the nHAMA can rapidly interact with P_mL_nDMA upon light exposure within 140 seconds and form an inorganic-organic co-crosslinked nanocomposite network. This bone ink was found to provide good mechanical strength and bioactivity for bone regeneration.

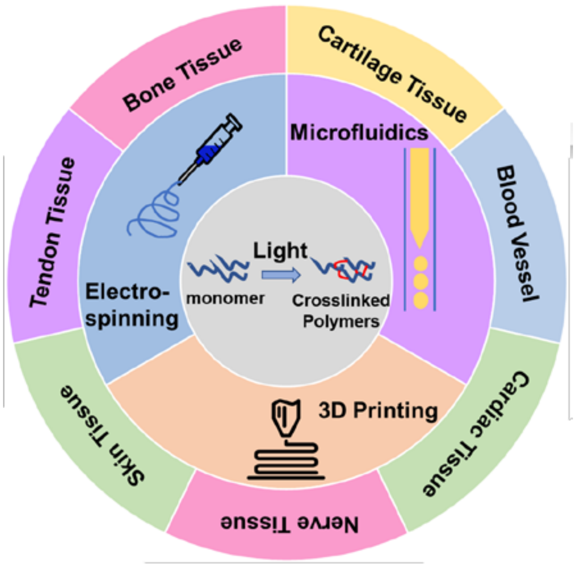

Figure 1. Fabrication and application of photocrosslinkable polymers.

References:

[1] Zhao, X., Liu, S., Cui, W., and Weitz D.. *Front. Biong. Biotechnol* **2016**.

[2] Yang, YH., Xu, TP., Zhang, Q., Piao, Y., Bei, HP., Zhao, X. *Small* **2021**, 2006598.

[3] Yang, YH., Zhang, Q., Xu, TP., Zhang, HY., Zhang, M., Lu, L., Hao, YF., Fuh, JYH., Zhao, X. *Biomaterials* **2020**, *263,* 120378.