Plasmonic Scaffolds for 3D SERS sensing

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Bioprinting has emerged as a promising tool for the rapid fabrication of scaffolds for supported tissue or tumour growth [1]. Numbers of biopolymer and hydrogel-based inks have been developed for the design of ever increasing complex 3D cell models. However, there is still a lack of detection tools able to precisely monitor cell behaviour within 3D microenvironments over long periods of time [2]. This issue can be addressed by incorporating additional functionalities to 3D printable inks to prepare scaffolds with sensing properties, able to monitor tissue growth or disease evolution. In this work, we evaluate the potential of a series of surface-enhanced Raman scattering (SERS) active inks for the detection of relevant analytes within a plasmonic hydrogel 3D-printed scaffold. SERS is an advantageous technique not only for *in situ* biosensing, but also for bioimaging of 3D cell cultures [3]. This technique takes advantage of the remarkable optical properties of noble metal nanoparticles due to their Localized Surface Plasmon Resonances (LSPR) that result in strong absorption and scattering of light at specific wavelengths, creating high local electric fields at the surface [4]. These electric fields enhance the Raman scattering of the molecules adsorbed to the metal surface and allow for extremely low detection limits. Furthermore, the excitation wavelength can be tuned to the near infrared range (NIR) matching the so-called biological transparency window (650-1350 nm) and, thus, improving light penetration in tissues. To produce SERS sensing scaffolds, different biopolymers have been combined and incorporated to plasmonic nanoparticle suspensions, such as gold nanorods (AuNRs) or gold nanostars (AuNSs). The applicability of SERS spectroscopy for the detection of model molecules such as 4-mercaptobenzoic acid (MBA) as well as relevant bioanalytes such as adenosine is demonstrated. These 3D printed plasmonic scaffolds show great potential for advanced 3D biosensing of cell-secreted molecules over extended periods of time.

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