

Plasmons for sensors implanted under the skin

Katja Buder, Katharina Käfer, Bastian Flietel, Celiksoy, S., Thies Schröder, Carsten Sönnichsen*

Department of Chemistry, Johannes Gutenberg University of Mainz, Germany

Macroporous hydrogels are an attractive platform for implantable sensors because the network of interconnected macropores facilitates tissue integration. Embedded sensing elements, in our case plasmonic gold nanoparticles, can transduce the presence, absence and concentration of biochemical markers to the outside [1]. We discuss how to integrate such nanosensors into a macroporous hydrogel while preserving nanosensor functionality, in order to produce implantable sensors. We demonstrate that out of four different polymers, a poly(2-hydroxyethyl methacrylate)-poly(ethylene glycol)diacrylate-copolymer (pHEMA-PEGDA) results in a working sensor [2]. Our approach of incorporating nano-sized sensor elements into a hydrogel matrix generally identifies suitable polymers for implantable sensor systems. We test the implants by detecting the presence and concentration of a drug (Kanamycin) in the blood of hairless rats.

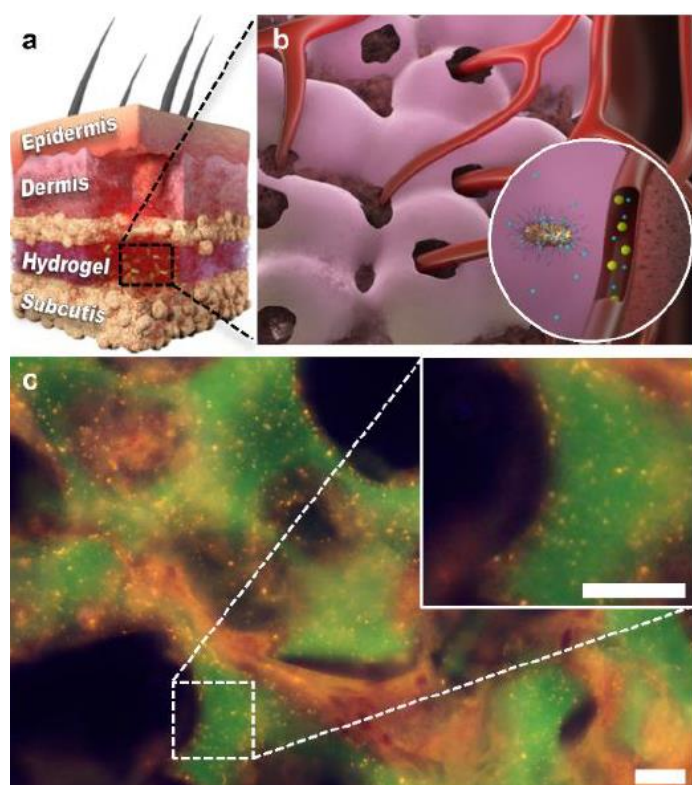


Fig. 1: The macroporous hydrogel implant. (a) Cross section of skin showing different layers and the hydrogel implant in the subcutaneous tissue. (b) Schematic of the hydrogel structure with embedded gold nanosensors. Tissue (brown) and blood vessels grow into the interconnected macropores facilitating analyte transport deep into the implant. The inset shows how small molecules (turquoise) diffuse to the nanosensors embedded in the hydrogel (pink). The hydrogel prevents larger molecules such as proteins (yellow) from reaching the sensors. (c) Dark-field image of a well-integrated hydrogel (histological section). Tissue (orange) has grown into the scaffold's macropores. The plasmonic nanosensors (small red dots) are visible inside the hydrogel matrix which appears green. The inset shows a magnified view of the evenly dispersed particles inside the gel. Scale bars are 20 µm.

[1] Käfer, K.; Buder, K (Krüger, K)*; Schlapp, F.; Uzun, H.; Celiksoy, S.; Flietel, B.; Heimann, A.; Schröder, T.; Kempfski, O.; Sönnichsen, C. *Nano Letters* 21 (2021) 3325 (* maiden name)

[2] Buder, K.; Käfer, K.; Flietel, B.; Uzun, H.; Schröder, T.; Sönnichsen, C. *ACS Applied Bio Materials* 5 (2022) 465–470.