Hydrogel Based Soft Pressure Sensor and Its Underwater Application

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Abstract

Future development of underwater robot calls for soft bodies with bionic designs instead of rigid members. Therefore, soft sensors for underwater applications are in urgent need. Herein, a hydrogel-based underwater acoustic sensor with high sensitivity to low-frequency sound is fabricated. Being a soft polymeric material, hydrogel is almost composed of water, and shows perfect acoustic impedance matching with water. To make hydrogel be responsive to underwater acoustic waves, Ag nano-dentrite is *in situ* synthesized at the interfacial zone in hydrogel matrix and serves as nanoporous microelectrode. Electric double layer (EDL) can only form along the surface of the Ag microelectrode where the pore size of nanostructures matches with the EDL thickness. Therefore, the hydrogel film can be regarded as an EDL capacitor, and its capacitance is mainly determined by the exposed area of the nanoporous microelectrode, which is changeable with an external pressure applied on the hydrogel surface. Based on this mechanism, the hydrogel sensor shows good performance on sensing underwater acoustic waves from 20 Hz to 2 kHz, providing an estimated sensitivity of 217 nF kPa $^{-1}$. Remarkably, it picks up acoustic waves and produces a signal 30 dB stronger at low frequencies (~ 20 Hz) than a commercial hydrophone.

Keywords: hydrogel; soft sensors; pressure sensing; underwater acoustic waves.

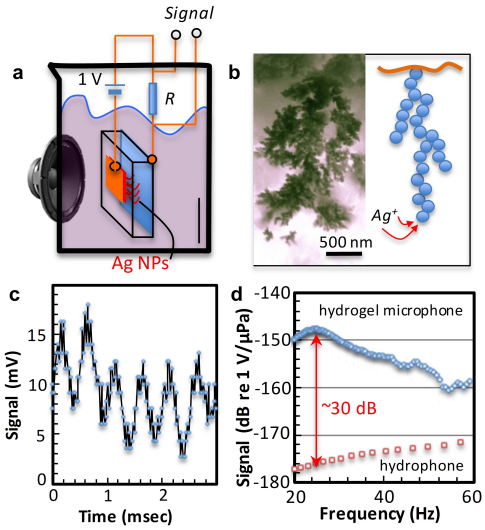

Figure 1. Schematic and performance of hydrogel-based underwater acoustic sensor. (a) Set-up of the hydrogel sensor. (b) SEM image and schematic of the Ag nano-dentrite inside hydrogel. (c) The hydrogel sensor is capable of detecting underwater sound at 2 kHz and (d) produces stronger signal at low frequencies than a commercial device (hydrophone).