Fast prototyping of conducting polymer microelectrodes using resistance-controlled high precision drilling

We present a straightforward method for fast prototyping of microelectrode arrays in the highly conductive polymer poly(3,4-ethylenedioxythiophene) (PEDOT). Microelectrode arrays were produced by electrical resistance-controlled microdrilling through an insulating polymer layer (TOPAS® 5013) covering a PEDOT layer. The sudden drop in electrical resistance between the metal drill and the PEDOT layer upon physical contact was employed as stop criterion for the drilling process. Arrays of 3×3 microelectrodes of diameter 30μm or 100μm, respectively, and having center-to-center electrode spacings of 130μm and 300μm, respectively, were fabricated. Their functionality was verified by chronoamperometry on potassium ferro-/ferricyanide. Comparison of the experimentally obtained results to finite element modeling of the respective electrode configurations shows that the conducting polymer electrodes approach the steady state currents predicted from modeling, but at a much slower rate than expected. This is shown to be caused by the use of electroactive PEDOT electrodes. Subtraction of the latter contribution gives approach to steady state currents within a few seconds, which is in very good agreement with the modeled response time.