Design and Material for a Polysiloxane Acrylate-based Penetrating Intracortical Neural Probe

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Despite significant demand for penetrating intracortical neural probes (PINPs), challenges remain regarding their biocompatibility and stability due to the mechanical mismatch between brain tissue and PINPs. Here, we propose a promising UV patternable polymeric material for PINPs and a design criterion for optimizing the geometry of polymeric PINPs. UV-curable polysiloxane acrylate (PSA) shows remarkably low cytotoxicity *in vitro*, comparable to that of polyimide. Real-time two-photon imaging of CX3CR1-gfp-Tg mice reveals that a PSA microneedle shows a markedly low immune-responsive effect. The photo-patternability and modulus-tunability of PSA provide effective design capability, even for hierarchical structures. Also, we found a design criterion suggesting minimized scar that can penetrate the tissue surface, reducing both iatrogenic injury and mechanical mismatch while simultaneously dampening tissue micromotion. This damping behaviour of polymeric PINPS was shown by both experimental methods and finite element method (FEM) simulation. Finally, we fabricated gold electrodes on PSA microneedles and successfully recorded LFPs (local field potentials) during seizure activity.