POMaC-based circuit board with biocompatible, biodegradable, and elastomeric properties

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Biocompatible, biodegradable, and elastomeric (BBE) printed circuit boards (PCBs) are a target goal across a variety of fields from traditional consumer electronics to applications in implantable and wearable devices. A desirable PCB should provide good electrical properties, shield internal components from the environment, and should be compatible with traditional microfabrication. Poly(octamethylene maleate (anhydride) citrate) (POMaC) an elastomer with tunable degradation and stiffness, good elasticity, and biocompatible properties presents an ideal elastomer for use as substrate for a BBE PCB, thus a POMaC-based circuit board with biocompatible, biodegradable, and elastomeric (PCB3E) properties is presented and analyzed for applicability. The pre-polymer was made in-house and synthesis optimized for desired molecular weight, monomer composition, and porosity. Boards were constructed using traditional microfabrication methods (spin-coating, sputtering, and encapsulation with bioprinter). Processing methods were investigated for desired thickness of board, tensile and degradation properties, basic cytocompatibility, and electrical properties. A simple LED circuit was designed and fabricated on a PCB3E and monitored in physiological conditions. The easy synthesis of the pre-polymer allows for large batch sizes and reproducibility. Various board thicknesses were obtained by varying spin speed and time during coating – thicknesses between 50-300 µm were achieved here. Multilayers can be deposited for further control of thickness or for variable tensile properties between layers. Post processing curing conditions and introduction of porogen can be used to select for desired tensile and degradation properties. The results indicate that the presented PCB3E can serve as a bioelectronic platform to be applied across a variety of fields by nature of the tunable tensile properties and degradation rate, simple manufacturing, and good electrical properties. Further work will investigate the functionality of more complex circuit types and direct integrations with cell cultures.