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Metastable polymer substrate for transient electronics

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ABSTRACT

Transient electronics are designed to operate for programmed life times and then degrade leaving little to no trace behind. The initial work on transient electronics has been focused on biomedical applications in which the electronics are implanted, but eventually degrade and resorb into the body after the treatment is complete [1]. Biomedical transient electronics typically use a water soluble substrate, such as silk that slowly degrades as water diffuses into the substrate. However, the ability to more precisely program the lifetime of electronics and utilize other degradation stimuli would enable new applications in a variety of industries. Essential to this effort is the development of a new class of degradable substrates that can be triggered to degrade by exposure to a variety of environmental stimuli (e.g., mechanical stress, UV light, pH). In this study, we present a photodegradable transient substrate made of cyclic poly(phthalaldehyde) (PPA) doped with a photo-acid generator (PAG). Exposing the substrate to UV light generates acid through reaction of the PAG which then promotes the cleavage of the acetal backbone of PPA, leading to rapid film degradation. We monitored the degradation of the film using dynamic mechanical analysis and Fourier transform infrared spectroscopy. Results demonstrate that the polymer degrades into monomer and that the degradation rate is controlled by varying the concentration of PAG and the intensity of the UV source. In addition, electronic transistors, diodes, and resistors were fabricated from magnesium and silicon nanomembranes using our newly designed substrate. A combination of transfer-printing and electron-beam evaporation were used to demonstrate lithographic compatibility. We demonstrate electronic transience of a Mg resistor in as fast as 20 minutes with substantial physical degradation in 72 hours.

REFERENCE

[1] Hwang, S.-W., et. al. *Science*. 2012, 337, 1640.