Circuit and Systems for Polymeric Implants: Designing Towards Increased Device Lifetimes

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For years, medical devices have relied on the titanium casing to protect the inside electronics and battery from the harsh environment of the body and vice versa. Such devices, however, end up being bulky and require major surgical interventions for implantation [1]. Driven by the increased functionality offered by CMOS technologies and the need for further miniaturization, in recent years tremendous efforts have been focused on designing miniaturized single-chip battery-less implants [2][3]. For encapsulation of such systems, certain polymers have been proposed that protect the sensitive electronics while maintaining the desired functionality within the expected lifetime [1-4].

One main drawback of polymeric encapsulation, however, is the eventual penetration of water through the polymer [1][4]. For this purpose, extensive effort has been carried out on investigating barriers and multi-layer coatings that could delay water and ion penetration and thereby, increase lifetime. Despite the increased protection offered by these layers, it has been shown that device lifetime can still be greatly reduced when employing certain signals within the system. For example, in [5], they have found that continued DC biasing of a wireless neural recorder reduced the lifetime of the device by a factor of 13 compared to a state where the devices were idle.

In this research, we intend to investigate the possibility of designing the system and ICs for polymeric implants in a way that could increase the lifetime while still preserving the intended functionality. To this end, we have divided the research into two main subsections: first, to investigate the underlying failure mechanisms for polymeric systems when exposed to physiological environments. Second, to propose system and circuit techniques that could extend the lifetime of these non-hermetic devices.

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