Fabrication, Characterization, and Modeling of a Biodegradable Battery for Transient Electronics

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Traditionally, emphasis has been placed on durable, long-lasting electronics. However, electronics that are meant to intentionally degrade over time can actually have significant practical applications. Biodegradable, or transient, electronics would open up opportunities in the field of medical implants, where the need for surgical removal of devices could be eliminated. Environmental sensors and, eventually, consumer electronics would also greatly benefit from this technology. The purpose of this project was to fabricate a functional biodegradable battery, characterize it, and model it. A battery with an Mg anode and Fe cathode was successfully fabricated, and characterization revealed the device was indeed biodegradable. A magnesium alloy was investigated as the anode material as well. Performance tests were done through galvanostatic discharges using constant and pulsed currents. Through the discharge tests, discharge time, capacity, energy, and power of the different batteries were calculated. An equivalent circuit model was developed to capture the battery's behavior by extracting fitting parameters from experimental data. All modeling work was completed using MATLAB. The size of the device and the power it produced are in accordance with typical requirements for transient systems, and the results of the alloy-based device surpass those seen for biodegradable batteries in literature. The model was able to accurately simulate device behavior, taking into account the intentional degradation, which has not been previously reported. The results of this research indicate an impactful technology, which can be used in several areas that affect our lives.