Characterization of Microfabricated Resistance Temperature Detectors for Electrochemical Measurements

Master's Professional Paper Presentation

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Microbial accumulation in the form of both planktonic flocs and surface-attached biofilm poses a complex problem in closed-loop water recycling systems. This problem is significantly amplified in settings where access to fresh water is extremely limited such as on low Earth orbit space stations and future advanced habitation systems for the Moon and Mars. As water supply to spacecrafts is limited and expensive, water is recycled through complex on-board water management systems. Water recycling systems incorporate water from multiple sources (humidity condensate, urine distillate, etc.), which all have high potential for biofouling. Previous work has demonstrated the success of microfabricated electrochemical impedance spectroscopy sensors for the detection of biofilms in complex systems; however, temperature fluctuations were not accounted for in these investigations. For future integration of these electrochemical sensors into remote systems, temperature must be considered to ensure the accuracy of the biofilm monitoring techniques.

This work describes the fabrication and testing of microfabricated resistance temperature detectors (RTDs) for use with electrochemical sensors. The fabrication process was validated through sheet resistance measurements of the gold thin film as well as with feature measurements. Following fabrication, the sensor response was analyzed through multiple testing procedures. These tests examined RTD sensitivity, stability, self-heating behavior, thermal response time, and hysteresis. The sensors exhibited a high sensitivity to temperature changes in the 0°C to 50°C temperature range and quick response times characteristic of microfabricated RTDs. The function of the sensors in a bioreactor was demonstrated through integration in the Simulated Microgravity Biofilm Reactor. From this work, improvements for future design iterations will be detailed.