

Paper-Based Microbial Fuel Cells for Self-Powered Sustainable Disease Diagnostics

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One of today's most pressing healthcare issues is that disease diagnostics are immensely expensive, invasive, painful, and time-consuming. This study developed a paper-based microbial fuel cell (pMFC) for measurement of uric acid (UA) and C-reactive protein (CRP) in saliva, which could be explored as biomarkers of kidney disease and cardiac disease, respectively. pMFCs utilized *S. oneidensis* to generate current through the oxidation of organic materials in the anodic reservoir, transferring electrons to the anode connected to the cathode via USB-6212. UA-monitoring pMFCs discerned between UA levels at risk for chronic kidney disease and healthy UA levels (70% voltage difference; $p < 0.05$). CRP-monitoring pMFCs discerned between CRP levels at risk for cardiac disease and healthy CRP levels in saliva (40% voltage difference; $p < 0.05$). Furthermore, reliability of pMFC-based cardiac disease was supported with the addition of clinic-based measurement of fibrinogen in serum. Fibrinogen-monitoring pMFCs fabricated in this study discerned between fibrinogen concentrations at high risk for venous thrombosis, a precursor to cardiac disease, and healthy fibrinogen levels (36% voltage difference; $p < 0.05$). Each single-use device costs \$0.15 to fabricate and requires a reusable \$2 voltmeter to read device output, which is significantly less expensive than traditional diagnostic methods. Overall, the pMFCs developed in this study may give individuals—specifically those with family histories of kidney/cardiac disease—insight into disease biomarker presence before disease onset and possibly increased severity. Future studies will develop pMFCs to detect allergen biomarkers.

Awards Won:

NASA: Second Award of \$750