Colorimetric Smartphone-Based Detection of Salivary SOD2 on Photonic Opal Structures for the Rapid Diagnosis of Hepatocellular Carcinoma

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Hepatocellular carcinoma (HCC) is the third leading cause of cancer deaths worldwide. Currently, HCC is diagnosed through blood tests, invasive liver biopsies, and costly imaging tests; and found in late-stages of the disease, when treatment is less optimal. As such, a rapid, low-cost, and non-invasive HCC detection system is needed to facilitate early detection not only in developed countries, but also in regions where access to medical care is difficult. This research focused on developing such a diagnostic tool, where onset HCC is detected by the presence of superoxide dismutase-2 (SOD2, an HCC-specific protein biomarker) in saliva. To prepare the photonic crystal (PC) microchip, 5 microliter of monodispersed poly(styrene-methyl-methacrylate-acrylic acid) latex spheres were spin-coated onto a PDMS glass substrate, and cured at 80oC for 2 hours. Inverse opal structures specific to SOD2 detection were created by dipping the microchip in prepolymer solution containing 1mg/ml SOD2, which is toluene-rinsed, and cleansed under 100W-UV within an acetic acid-SDS solution. The newly-created, SOD2-specific PC-microchip exhibits unique color changing properties from 400-800nm, when wet with 10 microliter saliva, and allowed to dry. While normal saliva produces a brown microchip color, saliva containing 5 microgram SOD2 produces green microchip reflectance, which is measurable at 500, 560, and 800nm wavelengths. Using a 4*[(A800-A500)/A560] model, normal saliva produces a ratio of 0.14, versus 0.34 for saliva with SOD2 that is commensurate with onset HHC. This demonstrated PC-microchip SOD2 detection selectivity and sensitivity, when paired with a smartphone RGB-indices spectral analysis, highlights the system’s usefulness for simple point-of-care detection of HCC, at $15/test.