

POINT-OF-CARE TSH MEASUREMENT USING A SMARTPHONE

#209

Polson, Randall¹; Espiritu, Theodore²; Lee, James³; Milham, Don⁵; Turbeville, Pamela⁵; Ehrenkrantz, Joel^{4, 5}

1. Dept. of Physics and Astronomy, University of Utah, Salt Lake City, UT, United States.
2. Dept. of Architecture and Planning, University of Utah, Salt Lake City, UT, United States.
3. R and D, True Diagnostics, Carlsbad, CA, United States.
4. Dept. of Medicine, Intermountain Healthcare, Salt Lake City, UT, United States.
5. i-calQ LLC, Salt Lake City, UT, United States.

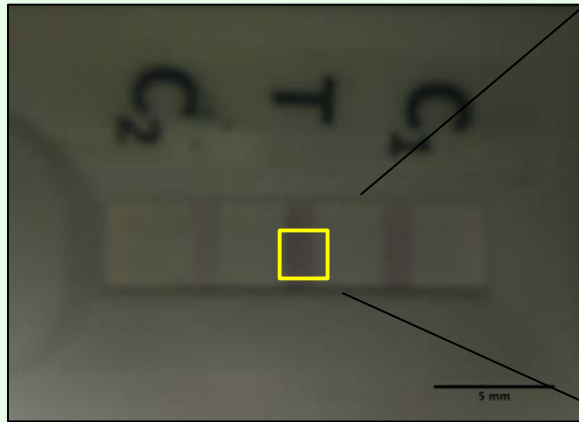


Fig. 1. Smartphone camera image of quantitative TSH immunochromatographic assay.

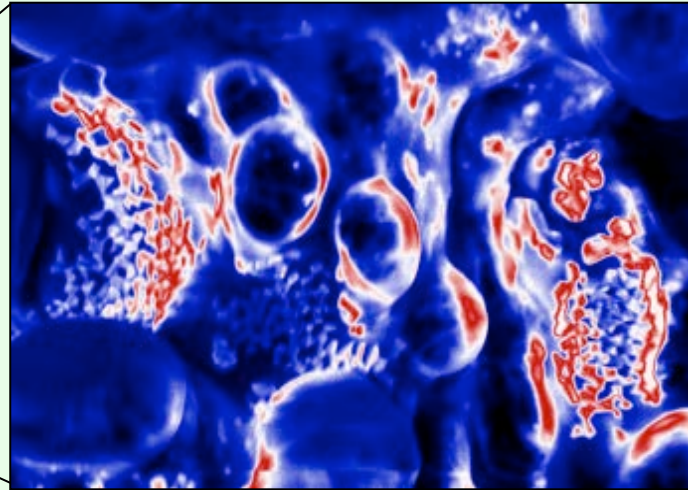


Fig. 2. 40,000 X scanning electron microscope image of colloid gold labeled anti-TSH antibodies (shown in red) attached to assay membrane (shown in blue).

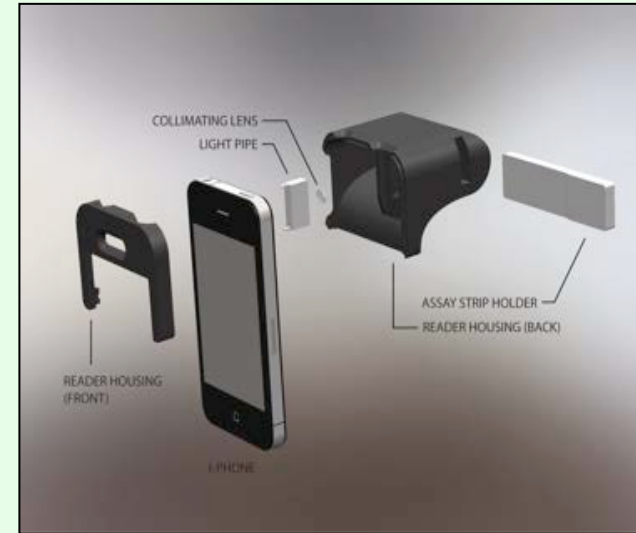


Figure 3: smartphone measurement apparatus.

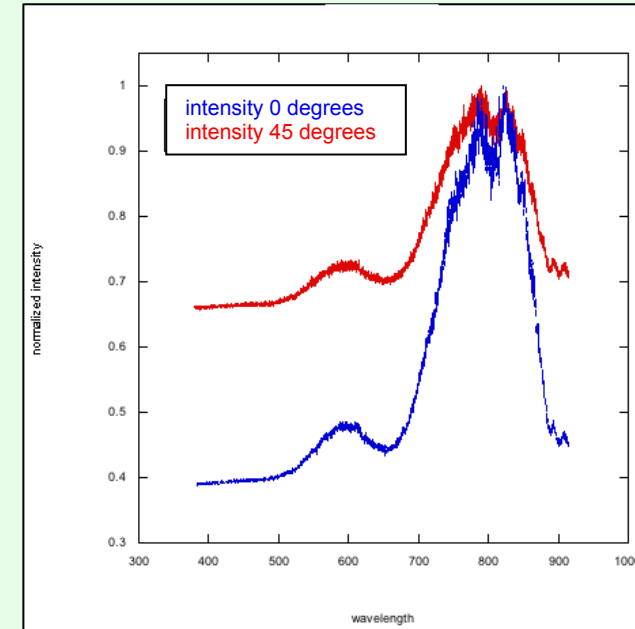
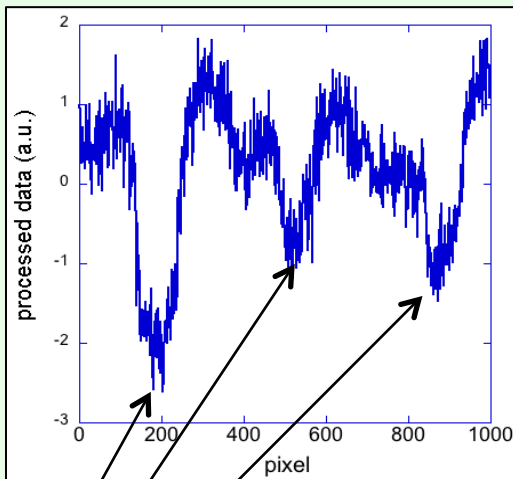


Fig. 4. Reflectance spectra of TSH assay at 0 degrees and 45 degrees.

Introduction: Point-of-care TSH immunochromatographic assays (TSH assay) are widely used to screen for hypothyroidism, but their acceptability is limited by the semi-quantitative nature of the test format and inability to detect low TSH values. TSH assays generate a visual signal by labeling TSH antibodies with colloidal gold nanoparticles. These particles have a diameter between 70 and 100 nanometers and a plasmon surface reflectance peak centered around 600 nanometers. Smartphones are equipped with an LED flash and digital camera which operate in the visible spectrum and thus can illuminate and detect colloidal gold. Smartphones are also able to perform image analysis using an imaging application ("app"). We have developed a device which uses a smartphone's flash, camera, and computation features to quantify point-of-care TSH assays.

Results: This smartphone-based imaging device was able to detect whole blood TSH concentrations as low as 0.1 mIU/L.

Conclusions: An inexpensive optical device, smartphone, and image analysis app can quantify an immunochromatographic TSH assay with sufficient sensitivity and precision to diagnose hyper and hypothyroidism and monitor thyroxine therapy at the point of care.



Processed image of TSH assay showing C2, T, and C1 bands. A TSH concentration of 0.1 mIU/L is shown here.