A smartphone-readable lateral flow assay for POC monitoring of urine ALCAM in lupus nephritis

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Systemic Lupus Erythematosus: Systemic autoimmune disease

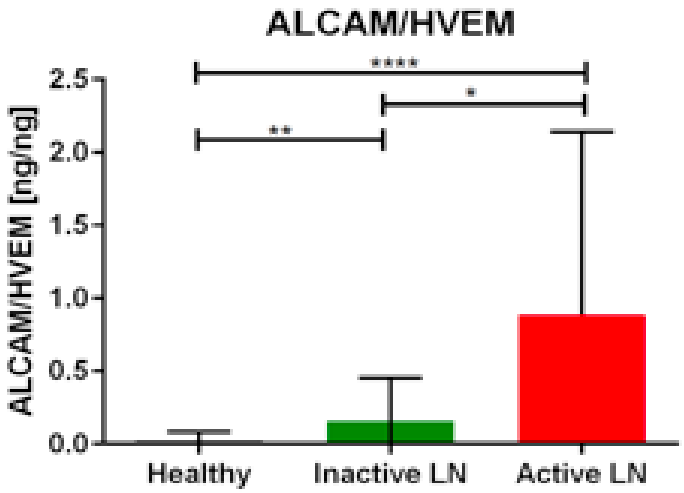
Lupus nephritis: Inflammation reaches kidney, leading to kidney transplantation and even death

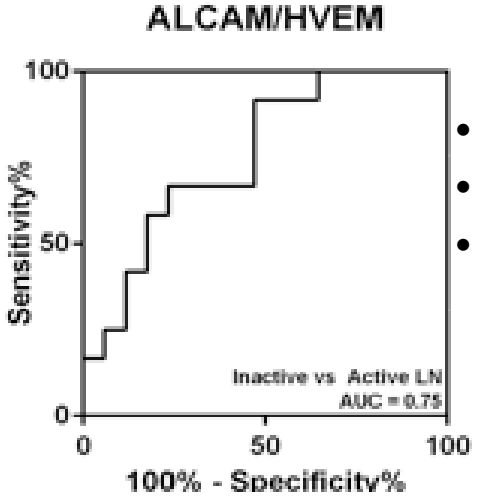
Current diagnosis: Renal Biopsy (invasive nature, inter-observer variance, attendant morbidity)

Next-generation diagnosis: Liquid biopsy (sensitive, quantitative, reproducible, user-friendly)

Urine ALCAM to self-detect the disease status

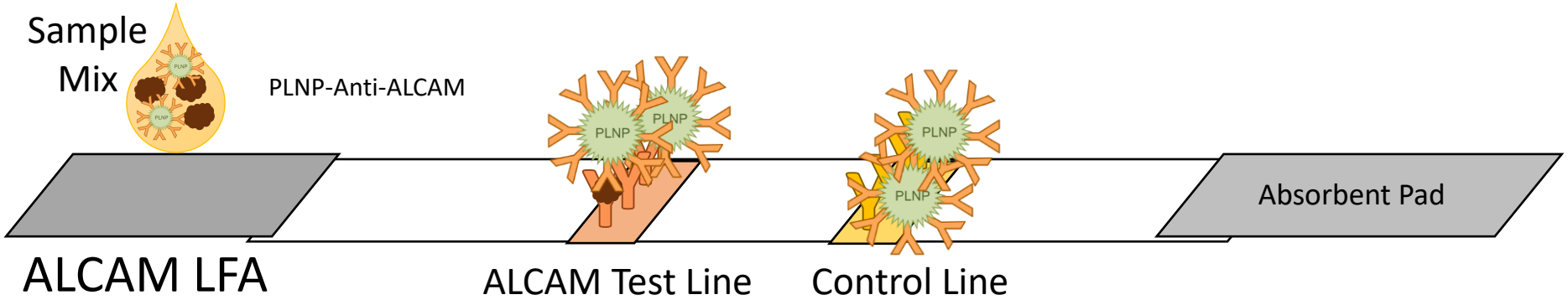
A. Lateral flow assay schematic

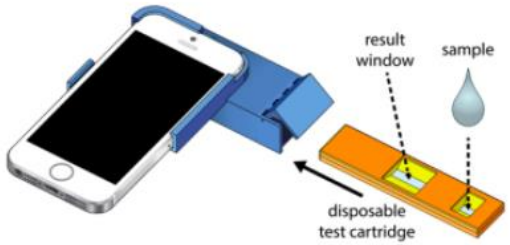




- For healthy urine, ALCAM concentration is below than 1 ng/ml
- For diseased urine, ALCAM concentration is 1 to 32 ng/ml
- Urinary ALCAM concentration is low for quantitation by LFA and calls for bright reporter.

Soomro S, et al. Unbiased Screening of Urinary Protein Biomarkers for Glomerular Filtration Rate Normalization [abstract]. *Arthritis Rheumatol*. 2017; 69 (suppl 10).





B. Strontium aluminate nanoparticles

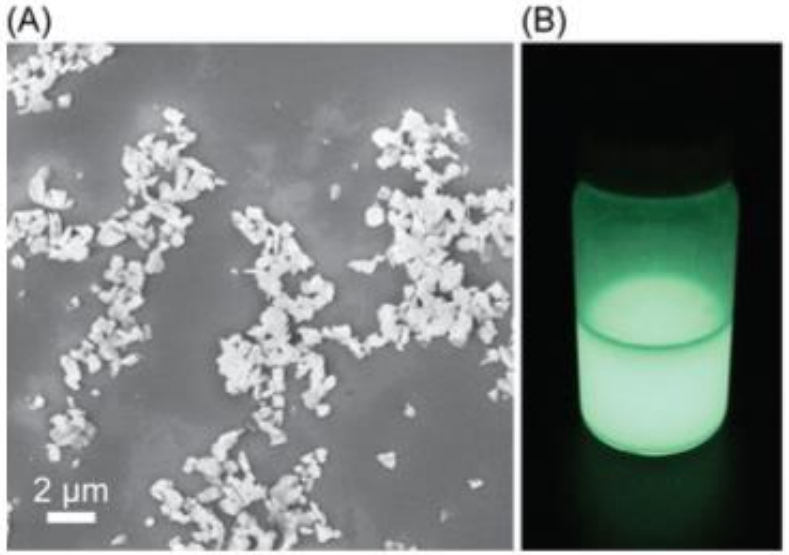


Figure 1. (A) SEM image of phosphors after 9 days of wet milling in ethyl acetate with zirconia grinding media. (B) Image showing luminescence from milled phosphors dispersed in ethanol after 30 s of excitation with 370 nm UV light.

Strontium aluminate nanoparticles with persistent luminescence

- Higher sensitivity and wider dynamic range than traditional gold nanoparticles
- Can be read at the point-of-care with cell phone

14 days milled phosphors

↓

fractionated phosphors

↓

silica-encapsulated phosphors

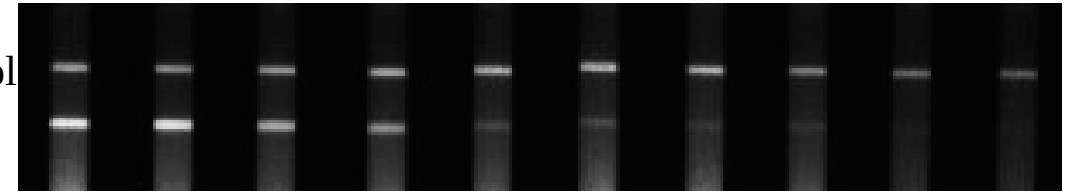
↓

conjugated phosphors

Anal. Chemistry 2014, 86, 9481-9488

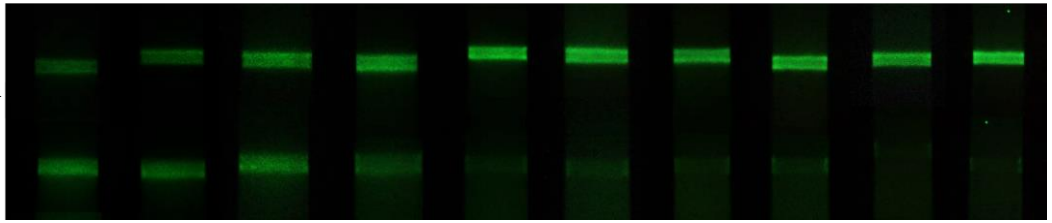
C. Serial dilution images by FluorChem and Cell phone

Control
Test

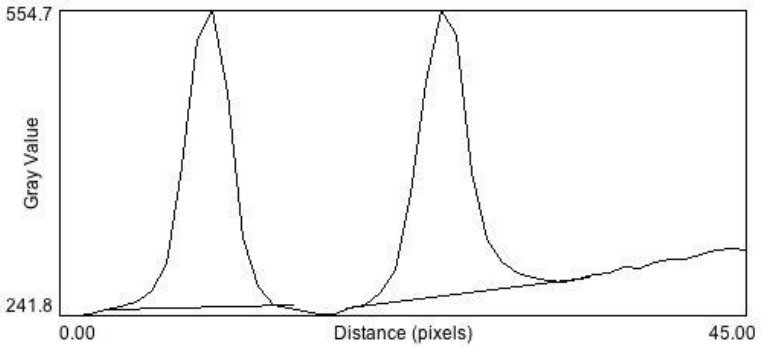


FluorChem (Gel documentation system)

Control
Test

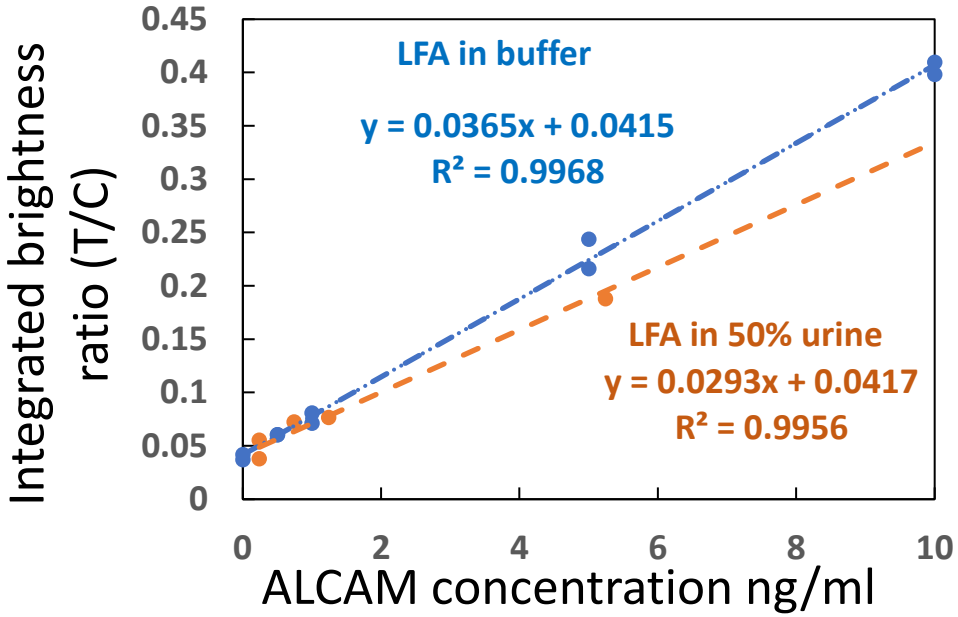


Cell phone



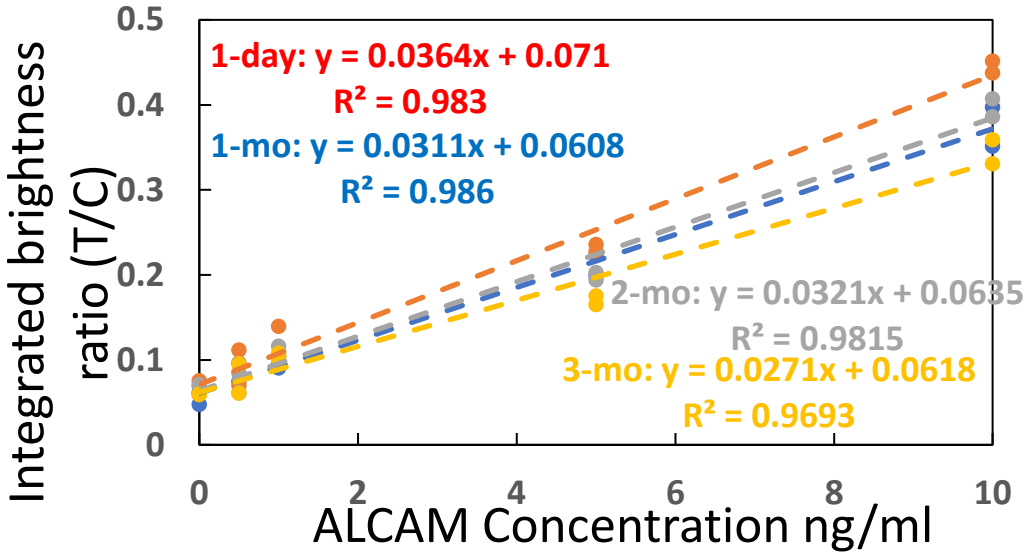
$$\text{Peak Area Ratio} = \frac{\text{Test Peak Area}}{\text{Control Peak Area}}$$

D. Urine feasibility under 50% urine

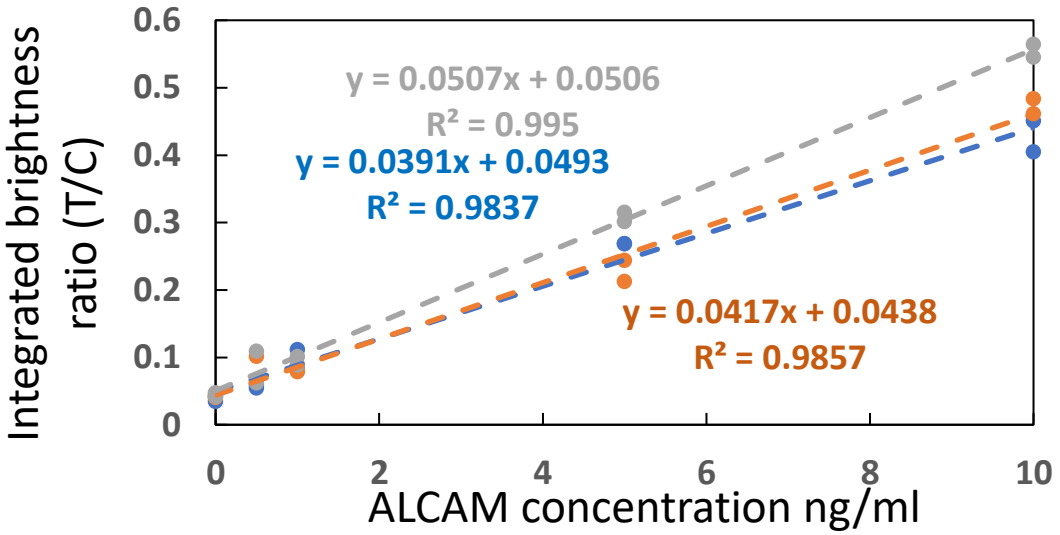


Assay performance was not much affected by up to 50% urine

E. Stability of nanoparticles at 20 °C



F. Reproducibility of nanoparticles preparation

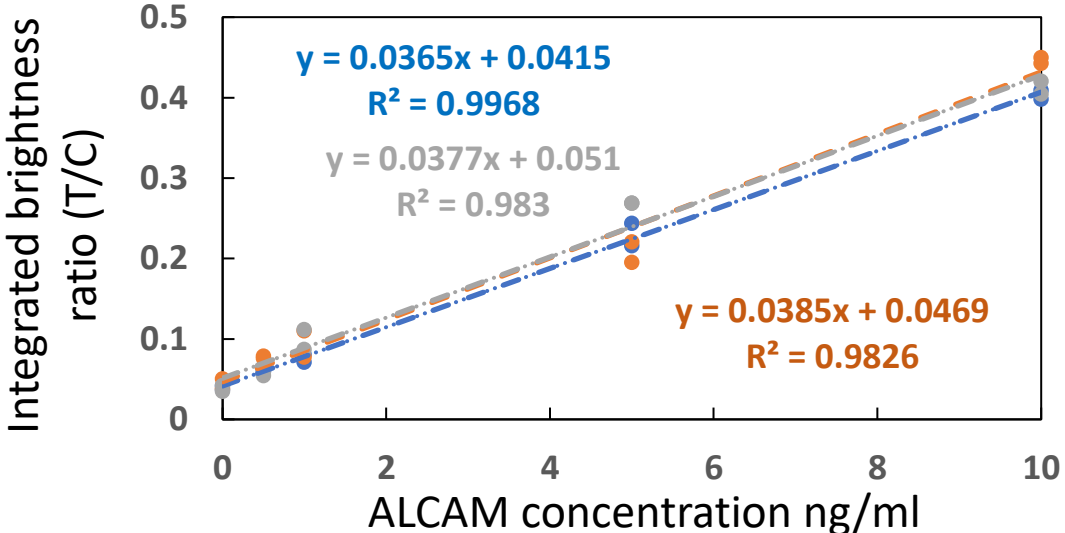


G. Stability of strips at 20 °C

ALCAM-LFA strip stability

Storage	Replicates	LoD (ng/ml)
0 (fresh)	3	0.89
1 mo	3	0.76 ± 0.225
3 mo	3	0.0553 ± 0.313
5 mo	3	0.5

H. Reproducibility of strip preparation



I: Next steps

- 100 urine samples screening for assay validation
- Inclusion of VCAM, L-selectin and CD163 specific biomarkers for a wider diagnosis of lupus nephritis

Questions?

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Disclaimer

RCW discloses inventor's interest in Luminostics, LLC, a PhD-student-driven spin-off from his laboratory which has received US FDA authorization for a COVID-19 antigen test based on nanophosphors