

Gel-based, 3D visual and colorimetric detection of a skin cancer biomarker using immunodiagnostic microneedles

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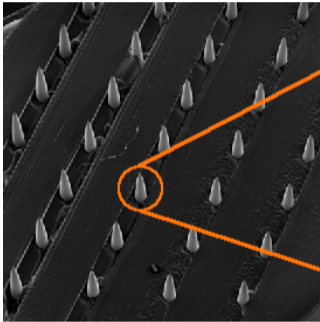
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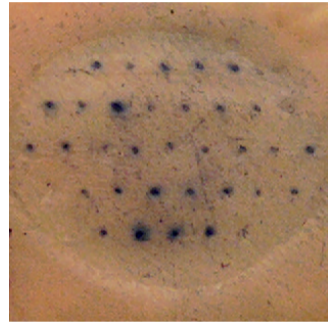
PharmSci 2019, Greenwich, UK

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Microneedles

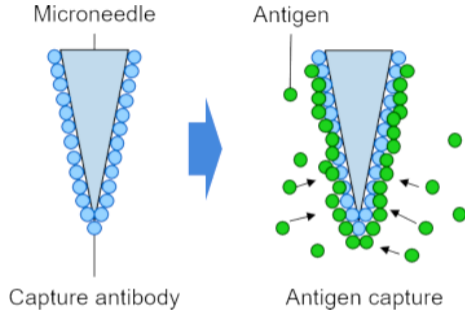


a. microneedle array



b. skin perforations

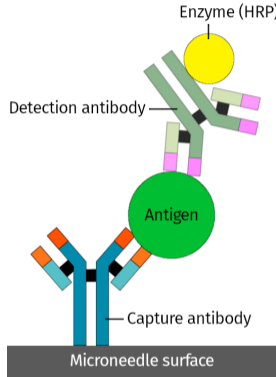
In-situ biomarker capture



Enzyme-linked immunosorbent assay (ELISA)

Monoclonal antibodies → antigen specificity

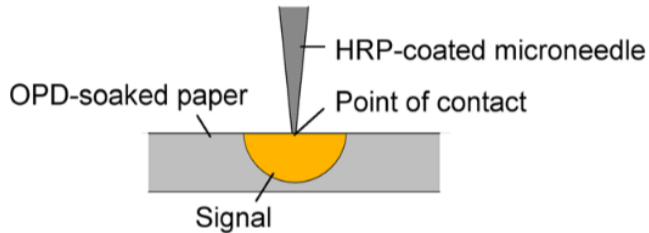
Detection of captured biomarker



Sandwich ELISA

Enzyme (HRP) + substrate (OPD) → colour signal

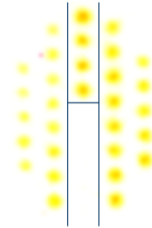
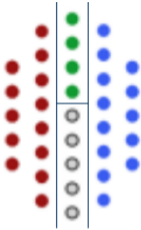
2D blotting technique



Persistent, digitisable blot pattern

Ng KW, et al. (2015) doi: [10.1007/s13346-015-0231-5](https://doi.org/10.1007/s13346-015-0231-5)

2D multiplex detection



Microneedle function:

- Capture Ag1
- Capture Ag2
- HRP (+ve control)
- BSA (-ve control)

Single positive

Ag 1⁺ / Ag2⁻

Double positive

Ag1⁺ / Ag2⁺

2D blotting technique

Benefits

- Facile
- Low cost
- Signal concentration
- Persistent signal
- Ease of digitisation

Limitations

- Partial signal
- Lacks 3D spatial details
- Difficult to quantify

Full signal
+
3D spatial data
+
Quantitative data

3D technique

Poke once, analyse twice

3D spatial data



Microscopy
Solid sample

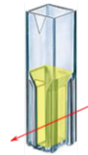
Gel



Liquefaction



Quantitative data



Spectrophotometry
Liquid sample



Gel-sol transition



Sol

Thermogelling substrate

Warm
Gel

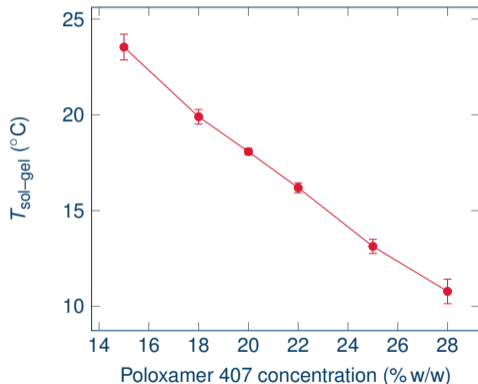


Cooling
Gel-sol transition



Cool
Sol

- **o-phenylenediamine (OPD)**
1.6 mg mL⁻¹
- **Phosphate citrate buffer**
0.05 M (pH 5.0)
- **Sodium perborate**
0.03% w/v
- **Poloxamer 407**
25% w/w



Data credit: Jonanna E. Hill-Tout

Detecting melanoma

S100B

- Histological marker for primary cutaneous melanoma
- Serum marker for metastatic melanoma

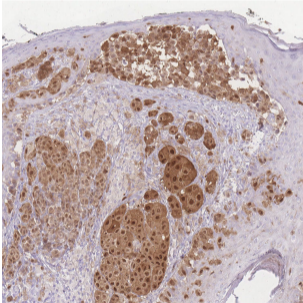
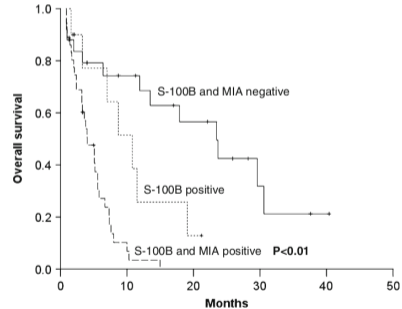
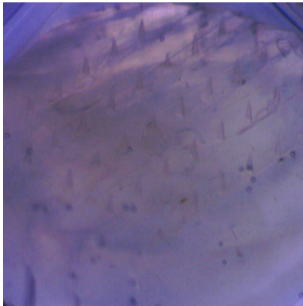


Image credit: Human Protein Atlas

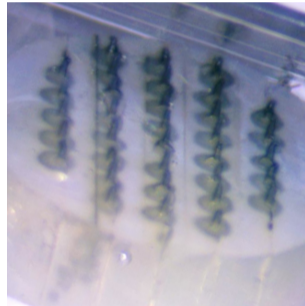


Díaz-Lagares A, et al. (2011) doi: [10.1007/s13277-011-0218-x](https://doi.org/10.1007/s13277-011-0218-x)

In-vitro biomarker capture in sample solutions



S100B⁻ sample
(-ve control)



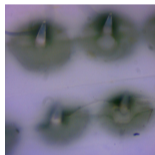
S100B⁺ sample
(100 ng mL⁻¹)

Quantitative data

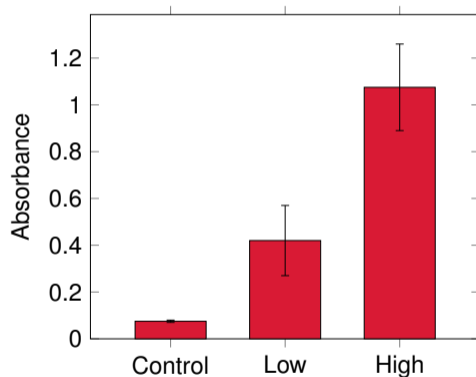
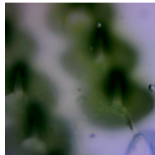
-ve control



Low capture



High capture

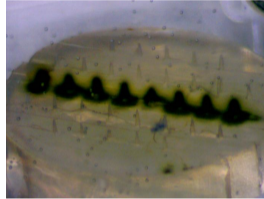


Multiplexing

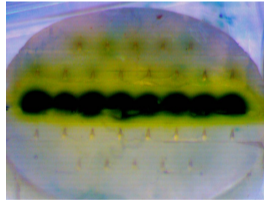


Microneedle function:

- S100B capture
- HRP (+ve control)
- BSA (-ve control)



S100B⁻ sample
(-ve control)



S100B⁺ sample
(100 ng mL⁻¹)

Summary

- Melanoma biomarker (S100B) detected in vitro.
- Thermogelling substrate: 'poke once, analyse twice'.
- Gel-phase: 3D spatial data by microscopy.
- Sol-phase: quantitative data by spectrophotometry.
- Ongoing development.
- Rapid, facile, minimally invasive, low-cost melanoma detection. 🙌