

Printed Functionality for improving vitality of people

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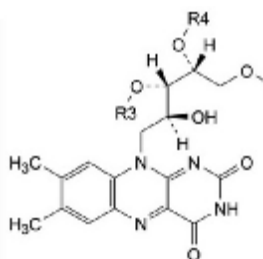
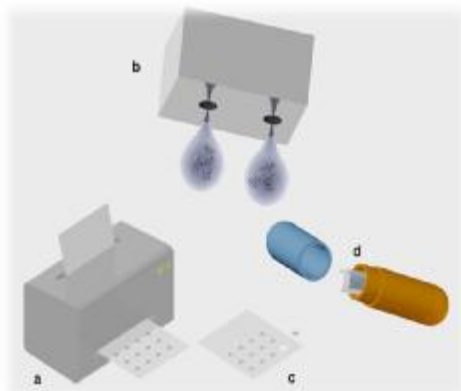
www.funmat.fi



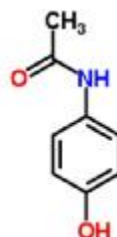
- q Conductive/semiconductive polymers
- q Metals, metal oxides
- q Organic semiconductors
- q Dielectrics
- q Electrolytes
- q Nanoparticles (organic/inorganic)
- q Dyes
- q Carbon Nanotubes
- q Smart polymers
- q Biomaterials (proteins, enzymes, cells)
- q Pharmaceutical materials
- q Resistors, conductors
- q Capacitors
- q Indicators
- q Sensors
- q Batteries
- q Transistors
- q Displays
- q Solar cells
- q RFID
- q Memory units
- q Bio-active paper
- q Smart packages
- q Bio-imaging
- q Drug dosing & delivery

Printable drugs

ÅAU-LPhC
ÅAU-Pharmacy
AaltoU-Machine Tech



Riboflavin sodium phosphate (vitamin B2)



Paracetamol

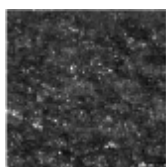


Caffeine

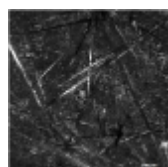
- Viscosity: 10 – 12 mPa s⁻¹
- Surface tension: 28 – 33 mN/m
- Particle size: < 500 nm



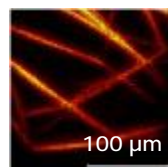
PET



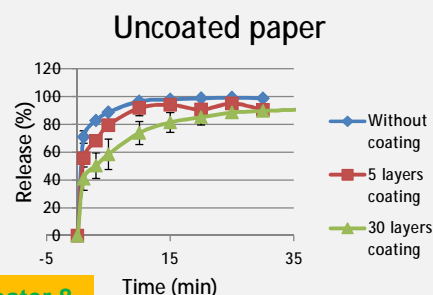
Uncoated paper



Coated paper



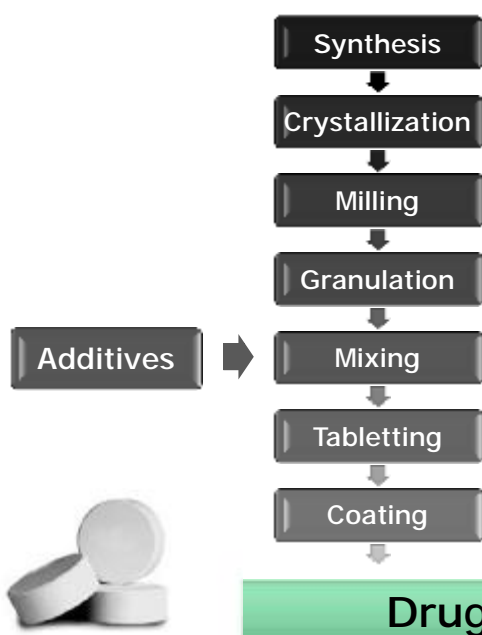
ToF-SIMS



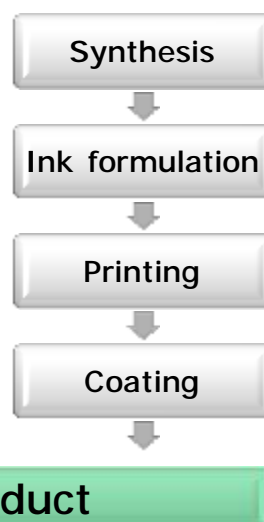
Sandler, Määttänen, Ihalainen, Kronberg, Meierjohann, Viitala, Peltonen, Journal of Pharmaceutical Sciences 100 (2011), 3386-3395.

Poster 8

Conventional tablet production:



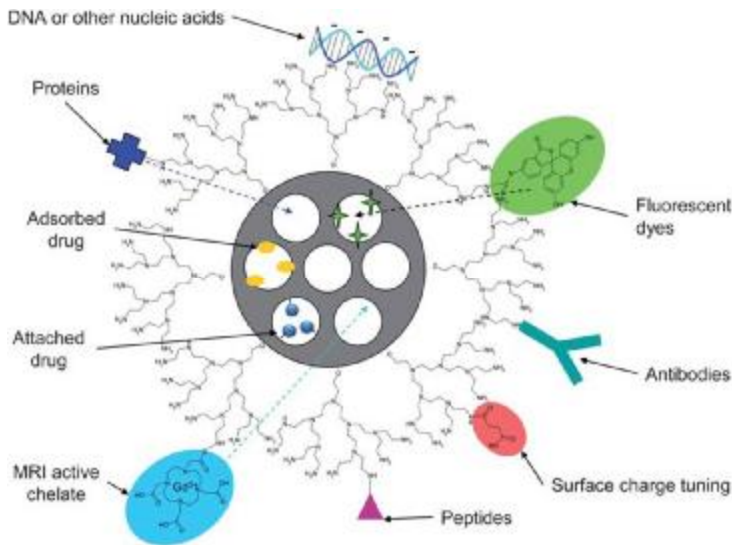
Printing process:



Enables Individualized dosing !



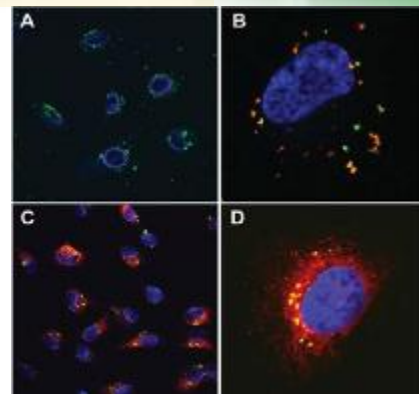
Targeted drug delivery



Cargo loading possibilities of mesoporous silica nanoparticles (MSNs).

ÅAU-LPhC
ÅAU-Biology

J. Rosenholm et al., *Nanoscale* 2010; *J. Mater. Chem.* 2010



MSN-mediated delivery of a dye (red) into HeLa cells.

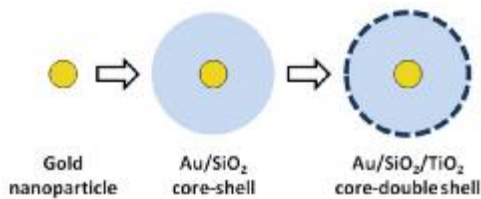
A. FITC-labeled particles (green) without cargo, stained cell nucleus (blue).

B. Dye-loaded MSNs (red) compartmentalized inside the cell.
C. Dye released into the cytoplasm.

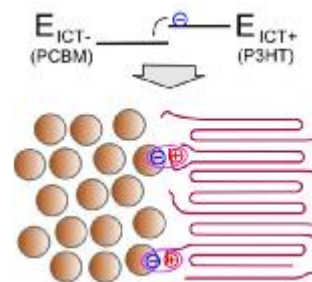
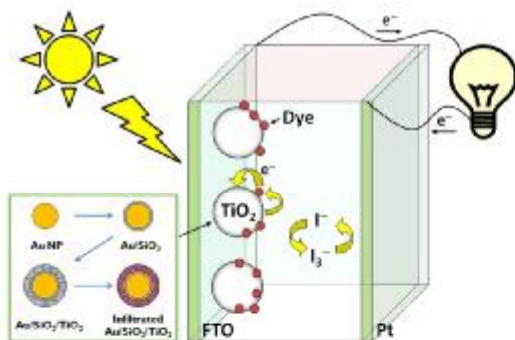
D. Close-up of a cell (3D image) after 24 h incubation.

Posters 5, 9, 10, 13

Dye-sensitized solar cells



Stöber process (50 to 1000 nm) or by binding SiO₂ to amino groups attached



Charge transport and recombination in organic and hybrid solar cells (Laboratory of Physics).

Poster 45

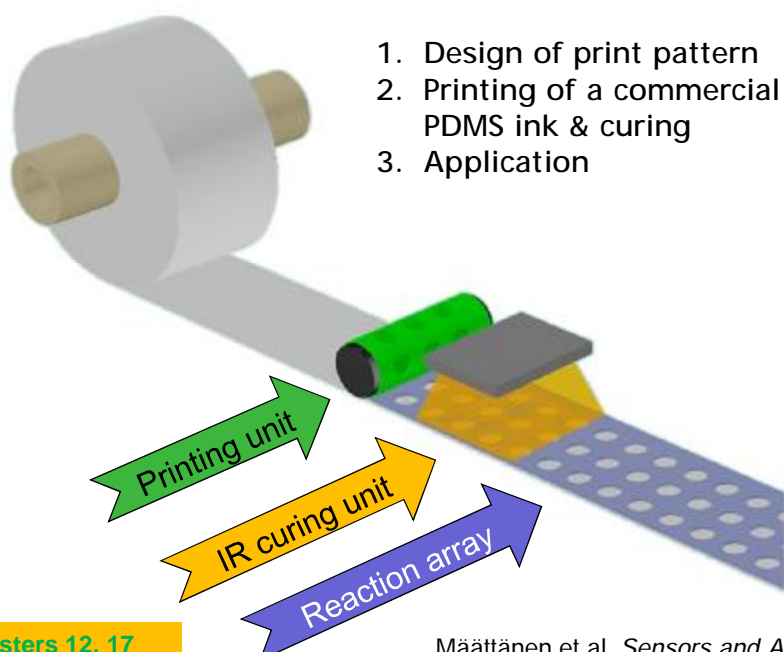
J-H Smått, R. Österbacka, et al.

ÅAU-LPhC
ÅAU-LPh

Why printed bio-sensors?

- q Health care costs rising
- q Early and easy diagnosis reduces treatment costs
- q Lab tests are slow and expensive
- q Printed sensors can provide a cheap and mass-produced solution for point-of-care (POC) treatment

Roll-to-roll fabrication of reaction plates



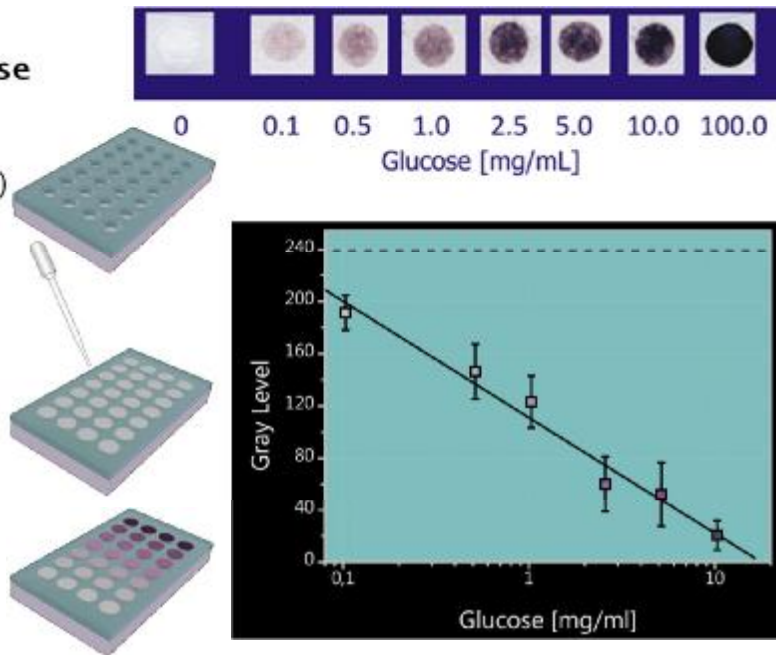
Printed colorimetric glucose sensor on copy paper

Roll-to-roll compatible glucose sensor fabrication steps:

1. Print glucose oxidase (GOx) over the reaction areas

Analysis steps:

1. Apply glucose solution in the reaction array
2. Wait for colour formation (~ 10 min)
3. Scan the sample
4. Analyse colour intensity



Poster 17

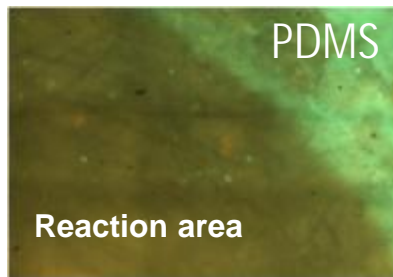
Määttänen et al. *Sensors and Actuators B* 160 (2011), 1401-1412

Printable 2D cell cultures

Fluorescence microscopy of retinal pigment epithelial cells (membranes stained with lipophilic DiO)



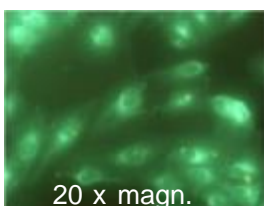
Kaolin – cell growth



PCC - Cell growth inhibited



Latex – cell growth



20 x magn.

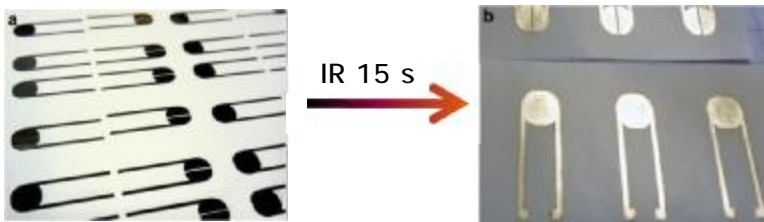
§ Cell growth can be tailored by surface energy, electrical properties, roughness, mechanical properties, pH, etc.

Synthesis and processing of conducting materials



Ink formulation

- Viscosity: 10 – 12 mPa s⁻¹
- Surface tension: 28 – 33 mN/m
- Particle size: < 500 nm



Sintering

With optimised printing parameters, a volume resistivity of $\sim 1.6 \times 10^{-7} \Omega \text{ m}$ was attained by a single print layer on paper.

Määttänen, Ihalainen, Pulkkinen, Wang, Tenhu, Peltonen, Applied Materials & Interfaces 4 (2012), 955-964.

Posters 20, 34

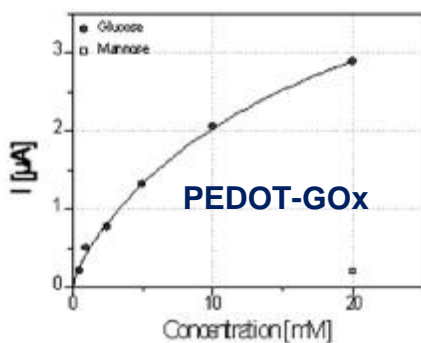
HU-LPC
ÅAU-LPhC

Electrochemical sensors

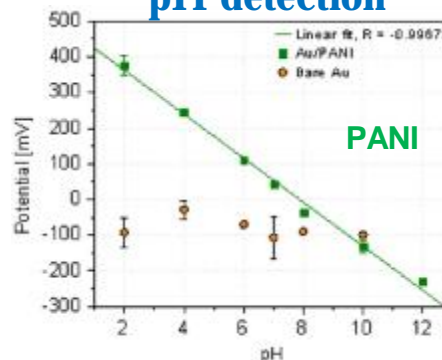


A printed electrochemical cell

Glucose detection



pH detection

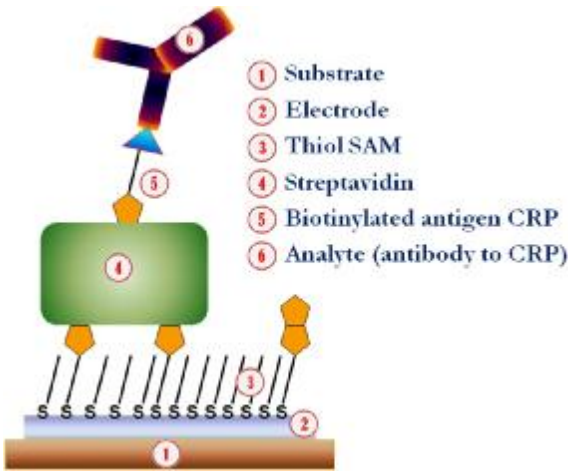


Ihalainen, Bobacka, Peltonen et al., submitted

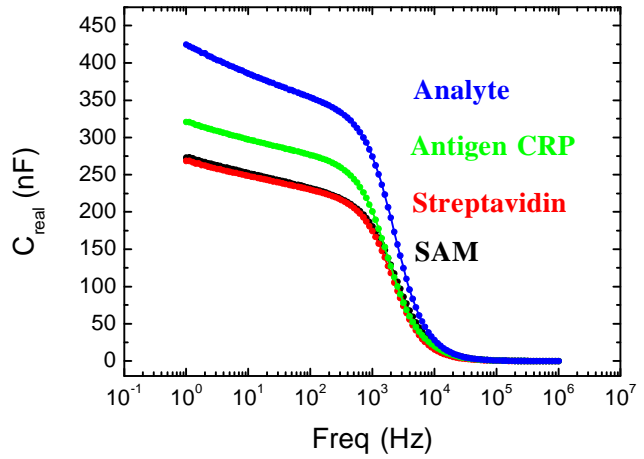
Poster 17

ÅAU-LPhC
ÅAU-Analytical Chem

An impedimetric biosensor



Biorecognition surface



Capacitive response

Ihalainen, Majumdar, Österbacka, Peltonen

Poster 20

ÅAU-LPhC
 ÅAU-LPh
 ÅAU-LPT
 TU-Biophysics

An electrical sensor with an indicator

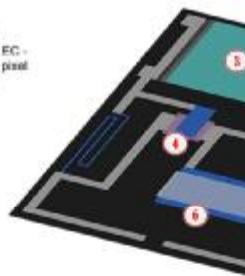
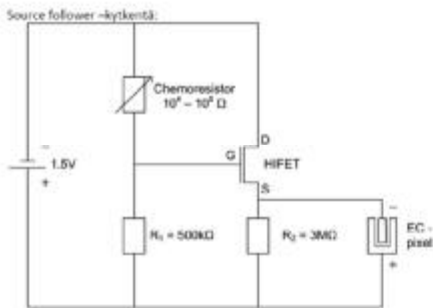


ÅAU-LPh

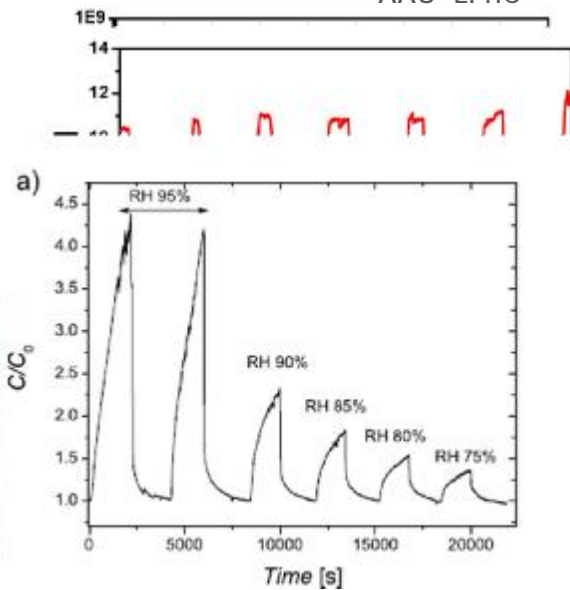


Turun yliopisto
 University of Turku

ÅAU-LPhC



- Topcoating
- Barrier layer
- Smoothing layer
- Precoating
- Basepaper



ÅAU-LPhC
 ÅAU-LPCC



TAMPERE UNIVERSITY OF TECHNOLOGY

ÅAU-LPT

Poster 34

Summary - outlook

- q A large variety of functional materials have been developed
- q These materials have enabled the development of simple and complex components, devices and systems and furthermore also test and application platforms
- q The future of printed functionality in improving the vitality of people indeed looks very promising



Thank You

for Your Attention