Low temperature assembly method of microfluidic bio-molecules detection device

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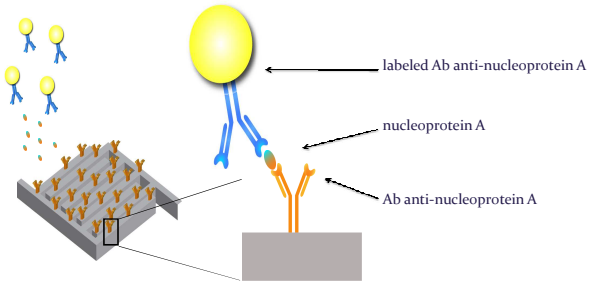
Detection principle of the microfluidic device

Detection target: nucleoprotein A (Influenza A virus proteins)
Sensor : interdigitated capacitive electrodes
Biofunctionalization: grafting of anti-nucleoprotein A antibodies on the electrodes

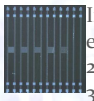
➔**Measurement:** the capacitance variation induced by the fixation of gold – labeled Ab anti-Influenza A on the sensing area



Assembly of the bio-sensor in DIL package

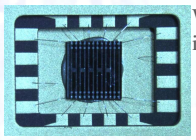
☹ The bio-sensor is sensitive to contaminants, temperature above 37°C and UV exposure ➔ *Need for alternative packaging method*

Die attach:
Standard: high T cure adhesive
➔ *Alternative: RT cure adhesive*



Interdigitated array micro-electrodes (IDAM): 4 sensors and 2 calibration structures, on a 3 x 3 mm² Si die

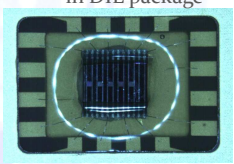
Wire bonding:
Standard: Au wire bonding (200°C)
➔ *Alternative: RT Al wire bonding*



Wire bonded die in DIL package

Encapsulation:
Standard: hight T curable encapsulant
➔ *Alternative: UV curable encapsulant*
- higher viscosity to define a sensing area
- lower viscosity to encapsulate the Al wires

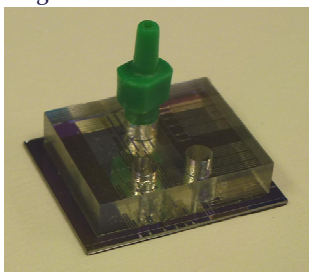
UV intensity: 18.5 W/cm², wavelength: 320 – 500 nm, duration: max 20 s



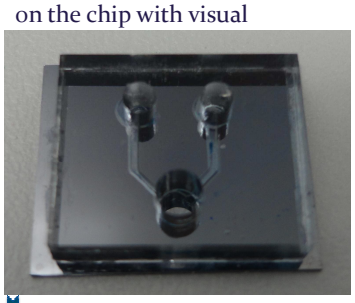
Encapsulated die in DIL package

Low temperature bonding of PMMA cover

First step:
- dispensing of epoxy adhesive on the KMPR on the Si die at RT
- Deposition of the PMMA cover on the chip with visual alignment

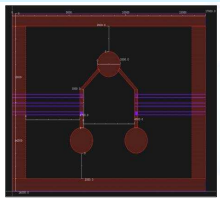


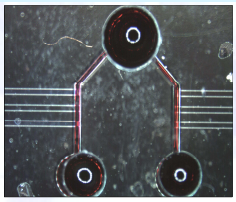
Second step:
- dispensing of epoxy adhesive on the PMMA, half cure (30 min at 60°C)
- PDMS stamp
- Deposition of the PMMA cover on the chip with visual

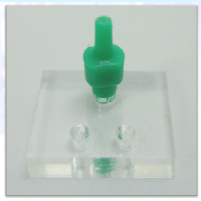


Integrated microfluidic chip

Integrated microfluidic chip with two sensing areas inside microfluidic channels for differential detection on silicon die with PMMA cover.







Description of the integrated chip:
- Silicon die: 17 x 14 mm²
- KMPR photoresist: 120 µm thick, 14.6 x 12 mm²
- 2 channels: 300 µm wide
- Transparent PMMA cover: 14.6 x 12 mm²
- 2 inlets, 1 outlet: 2 mm diameter

Bonding of the PMMA cover:
☹ The conventional methods (thermal, plasma, solvent bonding etc) are not suitable with the bio-layer grafted on the sensor

➔ Biocompatible low temperature adhesive

Assembly of the microfluidic chip on PCB

☹ The bio-sensor in microfluidic chip is sensitive to temperature above 37°C and UV exposure ➔ *Need for alternative packaging method*

Die attach:
Standard: high T cure adhesive
➔ *Alternative: RT cure adhesive*

Wire bonding:
Standard: Au wire bonding (200°C)
➔ *Alternative: RT Al wire bonding*

Encapsulation:
Standard: hight T curable encapsulant
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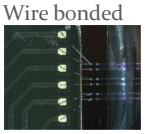
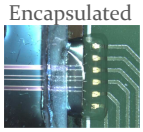
UV intensity: 18.5 W/cm², wavelength: 320 – 500 nm, duration: max 20 s

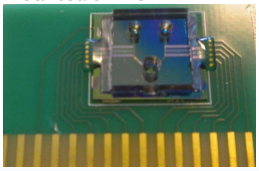
Wire bonded



Encapsulated

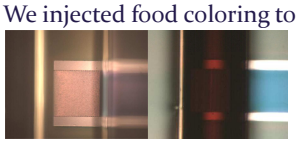


Mounted on PCB



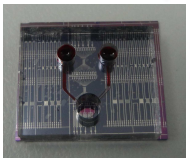
Results and conclusion

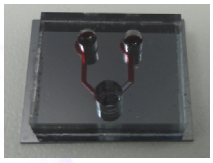
We injected food coloring to investigate the hermeticity :



Zoom on sensing area inside the channel. Without cover (left), with cover and coloring agent (right)

Food coloring in the channel confirmed gross-leak tightness:





We developed low temperature assembly methods which cause no damage to the biological layer grafted on the bio-sensor

Ref. :
N. Van Overstraeten-Schlögel *et al.*, *Bio-Sensing Technology conf.*, 2011.
S. Stoukatch *et al.*, *Plastic Electronics* conf., 2011.

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