EURIPIDES Forum 2010 in Paris

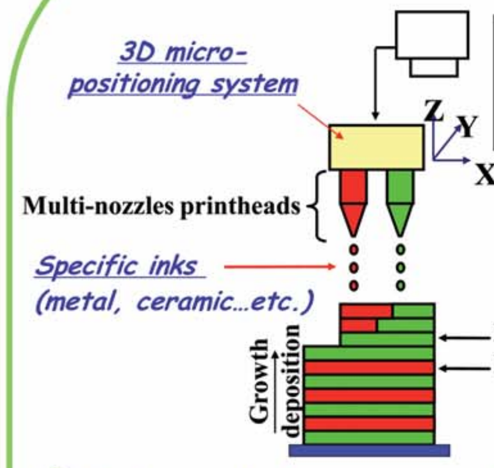
September 30th – October 1st, 2010 in Paris

CeramJet

Ceramic electronic components by inkjet printing

Ceradrop (Limoges – France) ; CMAC (Ronse – Belgium) ; Egide (Bollène – France) ; Eurofarad (Chanteloup-en-Brie – France) ; Heraeus (Hanau – Germany) ; SPCTS (Limoges – France)

Ink-Jet Printing : generalities



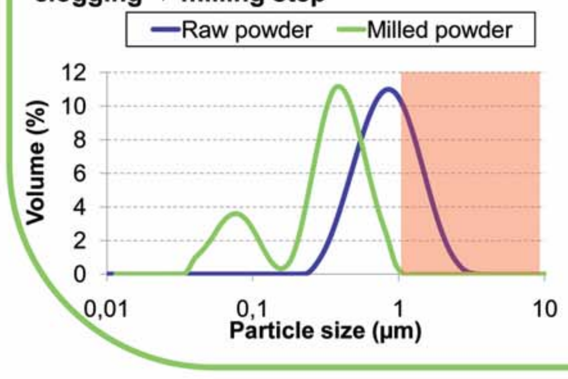
Patented technology (PCT/FR04/02150)

Ceraprinter X-Serie ©

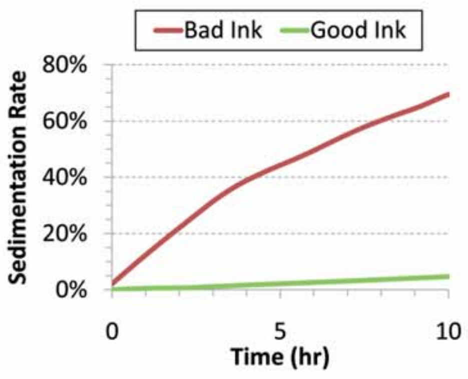
Before printing : preparing the right ink

① **Choose the right powder according to the targeted application**
- conduction, insulative, properties
- sintering temperature
- …

② **Adjust particle size to avoid nozzle clogging ⇨ milling step**



③ **Adjust dispersant nature and concentration for each powder to avoid powder settlement**



④ **Introduce the right additives to adjust :**
- quality of ejection,
- droplet spreading,
- layer drying,
- printed part mechanical properties

Reynolds

Weber

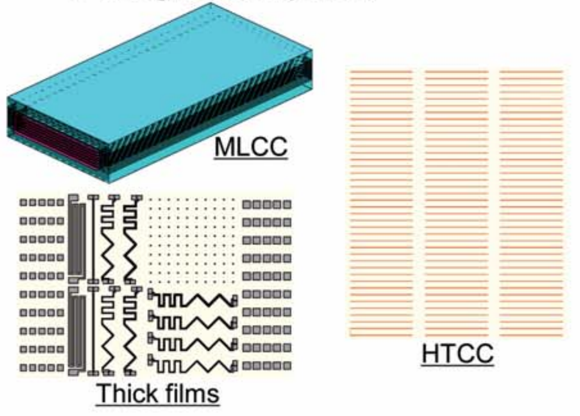
$$Re = \frac{\rho . r . v}{\eta} \qquad We = \frac{\rho . r . v^2}{\gamma}$$

$$1 < \frac{Re}{\sqrt{We}} = \frac{\sqrt{\gamma . \rho . r}}{\eta} < 10$$

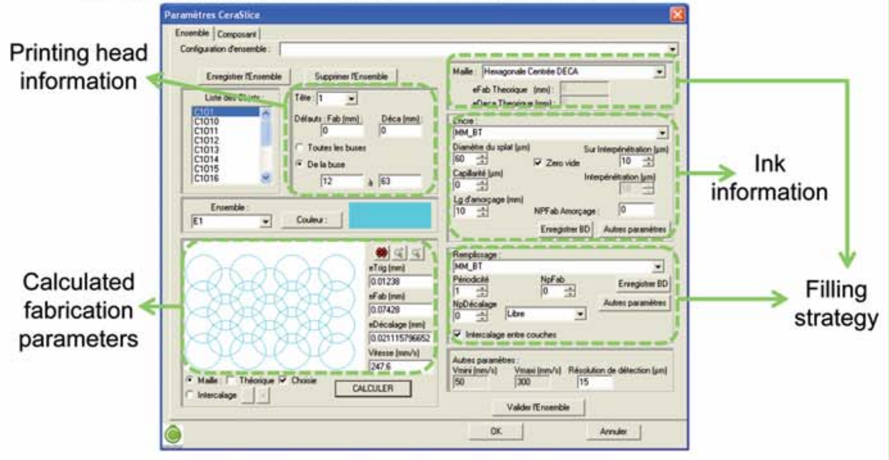
A software adapted to all the applications: CeraSlice

- ✓ Slicing software
- ✓ High level of flexibility and freedom in printing parts
- ✓ Specific tools for MLCC components
- ✓ Convenient for experimental designs in fabrication

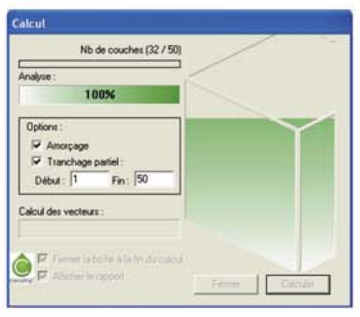
① **Design 3D component**



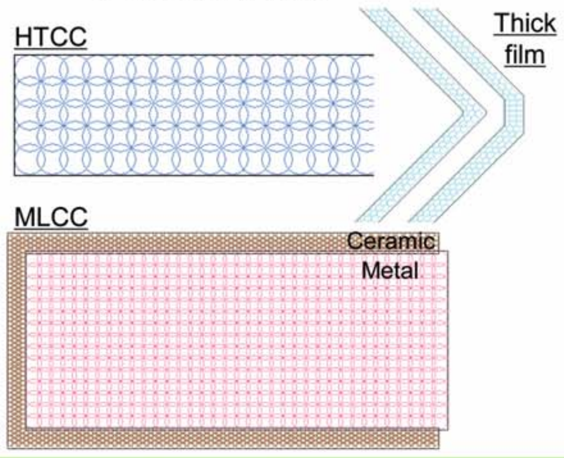
② **Select every parameters for each material**



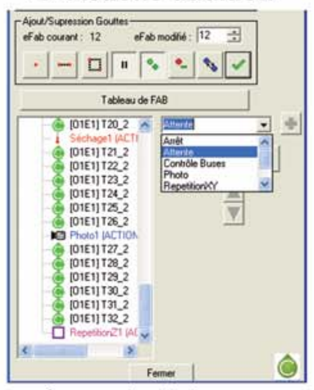
③ **Component slicing**



④ **Simulator check**



⑤ **Actions addition**

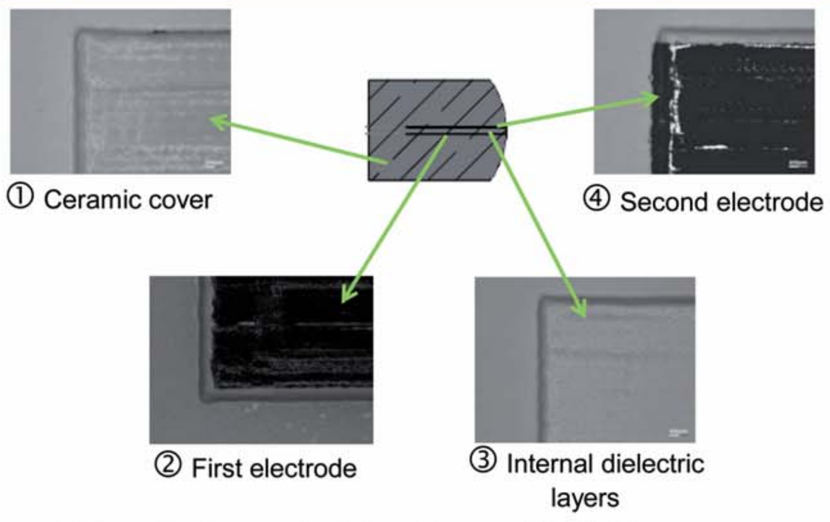


- ✓ on a single layer
- ✓ between 2 layers

Main Results

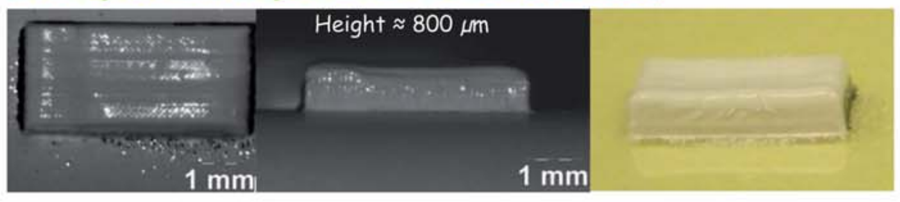
MLCC

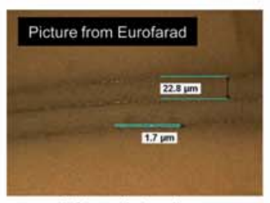
Progressive fabrication without moving the sample



- ✓ Automatic change of printhead for use of both inks
- ✓ High precision for electrode printing : 120 µm margins respect

Complete component : 15 electrodes



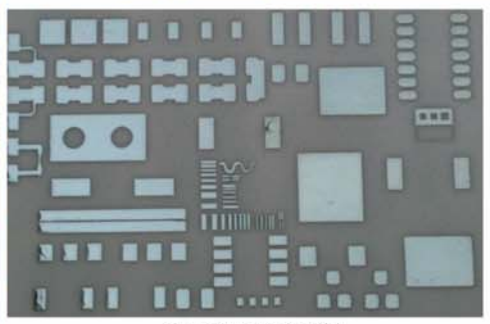


After sintering

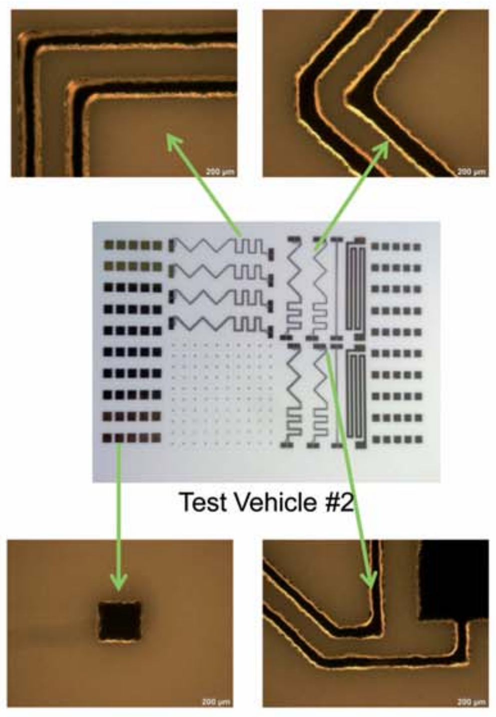
- ✓ Crack-free parts
- ✓ Straight sides in the 3 dimensions
- ✓ Use of a removable organic substrate⇨ no binding after sintering
- ✓Required thicknesses for internal electrodes and dielectric layers are reached

Thick Films

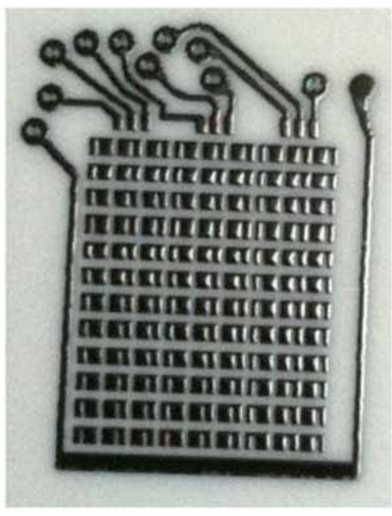
Ag components on dense ceramic substrate



Test Vehicle #1



Test Vehicle #2



Demonstrator

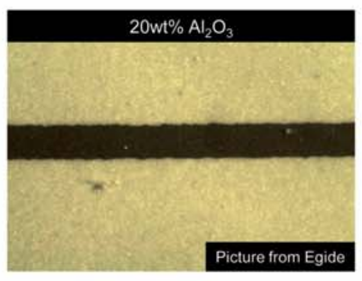
- ✓ Good droplet positioning, excellent repeatability
- ✓ Good line definition
- ✓ About 10 µm thick
- ✓ Reproducible manufacturing
- ✓ Crack-free green and sintered tracks

- ✓ Component 100% solderwetting
- ✓ Good silver adhesion on the substrate
- ✓ Correct conductivity after sintering

HTCC

W/Al_2O_3 tracks

20wt% Al_2O_3

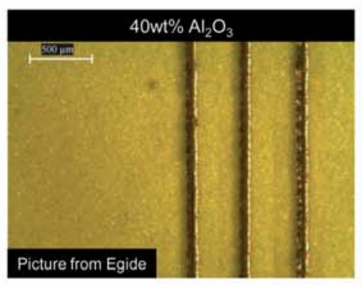


Picture from Egide

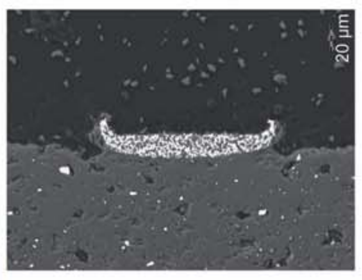
30wt% Al_2O_3

Picture from SPCTS

40wt% Al_2O_3

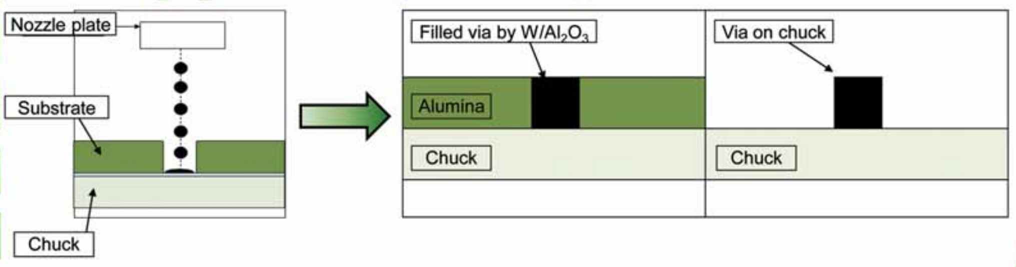


Picture from Egide



- ✓ Good continuous and crack-free tracks
- ✓Al_2O_3 ratio ↗ ⇨ no cracks after sintering but substrate torn on the edges
- ✓Al_2O_3 ratio ↗ ⇨ tracks conductivity ↘ (better when tracks are buried)

W/Al_2O_3 vias filling feasability



- ✓ Vias (60 & 200 µm) can be filled by ink jet printing process
- ✓ When substrate taken off the chuck, filled vias stay on the chuck
- ✓ Addition of a removable organic sheet between substrate and chuck

Perspectives

MLCC

- Identify final metal ink
- Control dielectric properties
- Print completely straight parts
- Reach the same results on bigger components
- Develop new functionalities of CeraSlice too allow printing of crack-free big parts.

Thick Films

- Make exactly the same parts as industrial actors today by ink-jet printing

⇨ Transfer Ink-Jet Printing process to industry

HTCC

- Work on W/Al_2O_3 formulation (ejection is still too changing in time)
- Electrical chacterisation s of other test vehicles
- Sintering trials on other test vehicles
- Enlarge ink formulation so as it can be used for several applications
- Improve vias filling