Exploring Multimaterial printing for Rapid Prototyping of Multilayer Hybrid Ceramic Components

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Motivation

- Maskless printing technology for fabricating multilayer hybrid ceramic components
- Development of glass-ceramic based ink formulations for digital printing technologies
- Co-printing and co-sintering behavior functional layers with dielectric layers
- Manufacturing of printed hybrid ceramic components.
- Determining the performance, functionality, and reliability of printed electronic devices
- Rapid prototyping of robust, defect-free multilayer hybrid ceramic components

Key Points

- Need for developing innovative dielectric inks tailored for digital printing
- Hybrid materials deposition technology (3 x Inkjet and 1 x Aerosol Jet Head)
- In-line multi-curing/sintering technologies integrated
- In-line characterization device (Laser reflectometer)
- Optimizing energy consumption in Multimaterial Printing processes
- Striving for sustainability in 3D printed electronics manufacturing

Challenges

- Addressing challenges in achieving precise particle size
- Overcoming challenges in ink formulation tailored for Inkjet Printheads
- Addressing challenges in simultaneous deposition of multiple materials
- Optimization of printing parameters for ink fluidity and stability
- In-Line sintering (NIR, photonic) of dielectric ceramic- and metallic inks
- Ensuring compatibility between different materials

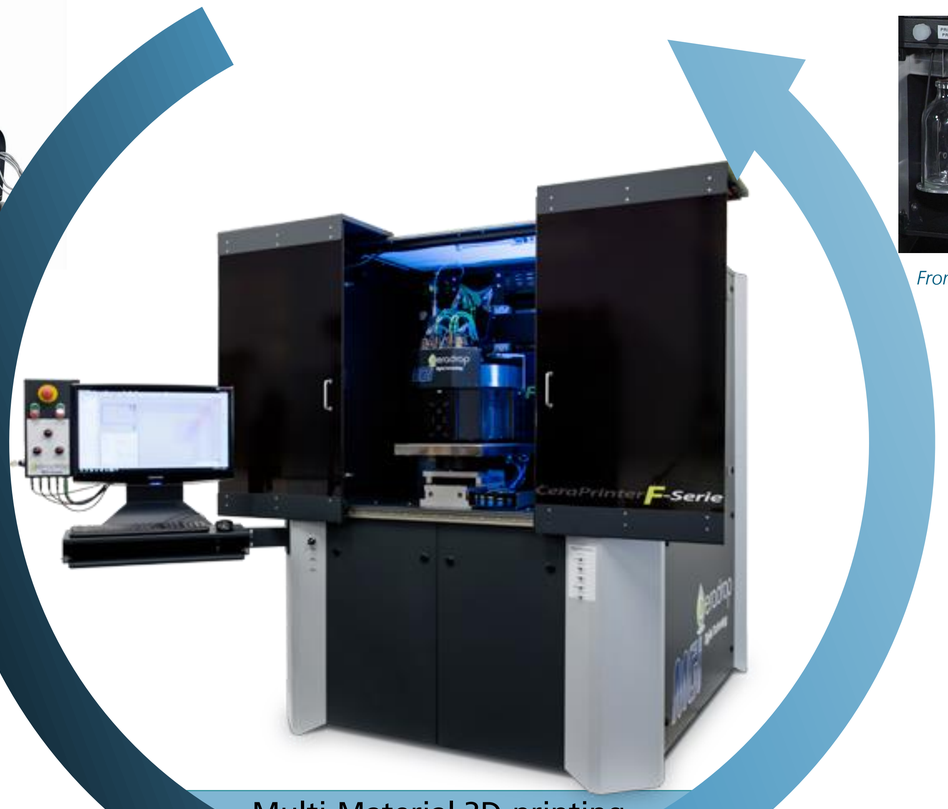
Material Preparation

- Milling:
  - Particle size < 1µm
  - Particle size distribution
  - Characterization

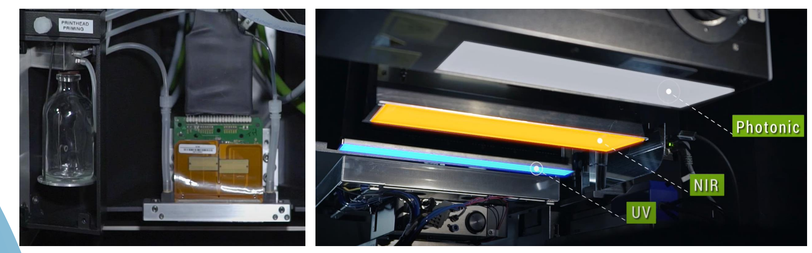
AHM 142 agitator bead milling

Ink Formulation

- Properties:
  - Viscosity 8-12 cP
  - Surface tension 36-42 mN/m
  - Density ~ 1 g/cm³
  - Al_2O_3 ink, LTCC ink, TiO_2 ink



Printing and sintering technology

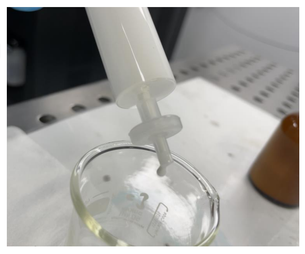


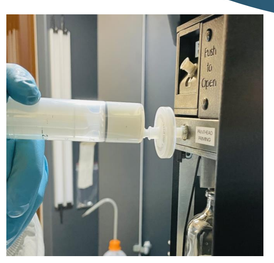
From Cartridge to industrial printheads , Integrated Curing/Sintering Module (Source: Ceradrop)

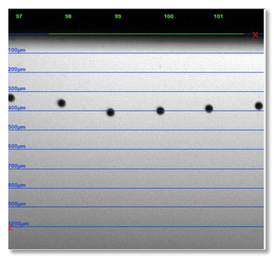
- Process:
  - Fully digital and maskless technology
  - Suitable with a wide range of inks and pastes
  - Layer-by-layer deposition and cured between layers
  - Integrated drying / curing process (UV, AdphosNIR, Novacentrix PulseForge)
  - Working area of 305 x 305 mm²

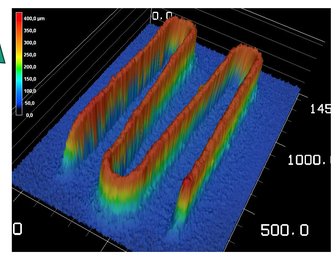
Preparation and Multi-Material 3D-printing

- Process:
  - Filtering the ink
  - Waveform optimization
  - Advanced software to import/ edit /simulate the printing layout
  - Automated real time drop jetting analysis software
  - Post-printing characterization software

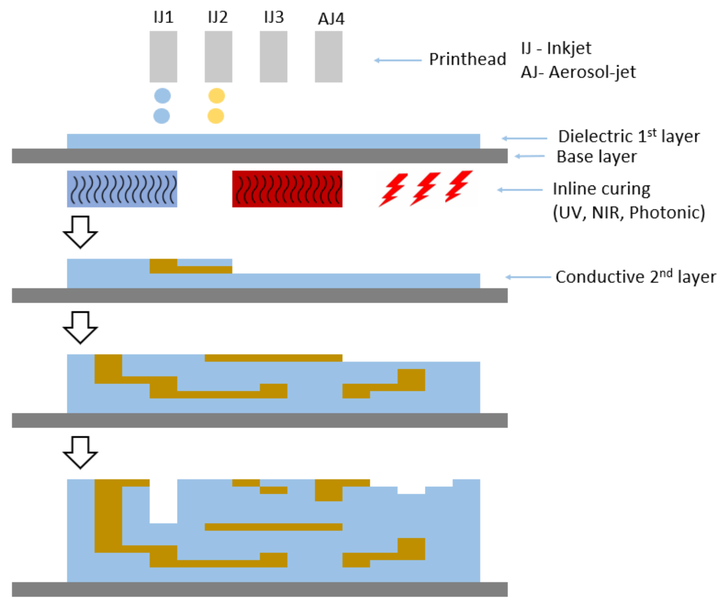






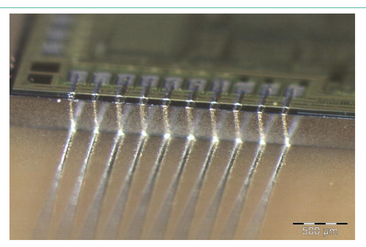


Multimaterial Printing Process Approach



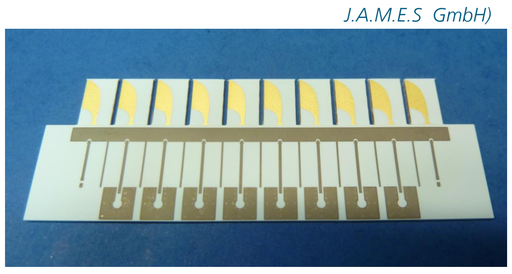
Applications

- Designed for Advanced Digital Process Development in multidisciplinary fields such as LTCC, multilayer ceramic components and printed electronic applications like: RFIDs, interconnection of chips, photodetectors, lenses, semiconductor printing, sensors, piezoelectric actuators and fuel cells
- Development of high-resolution structures suitable for applications in printed electronics, including both low and high-frequency devices
- Offering a range of services in collaboration with industry and scientific partners in 3D Printed Electronics



Aerosol jet printing for chip contacting

Printing on 3D surfaces (in cooperation with J.A.M.E.S GmbH)



Printed Vivaldi antennas on free standing ceramic membrane

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