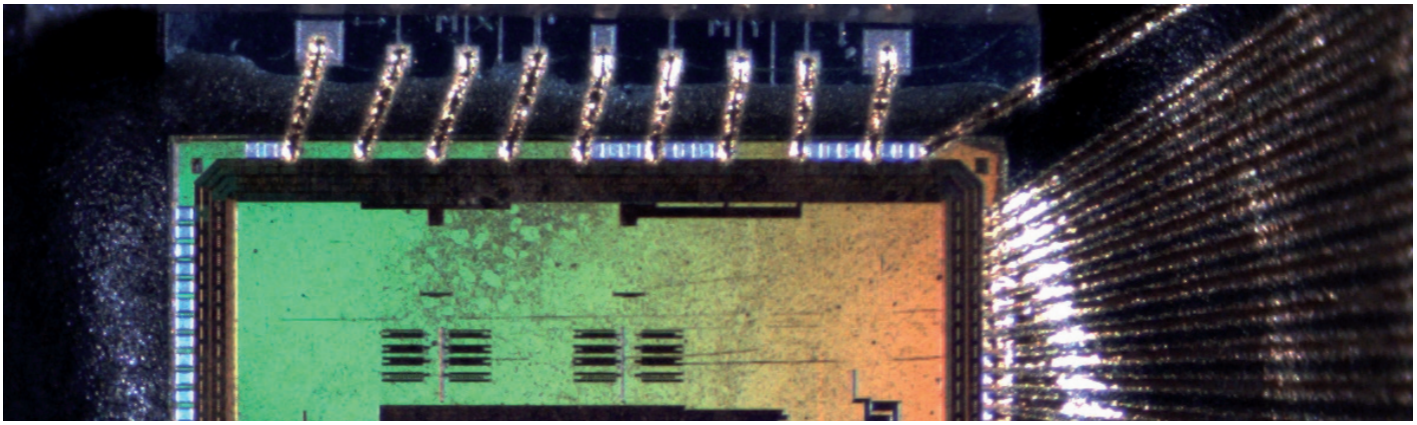
AEROSOL JET PRINTING



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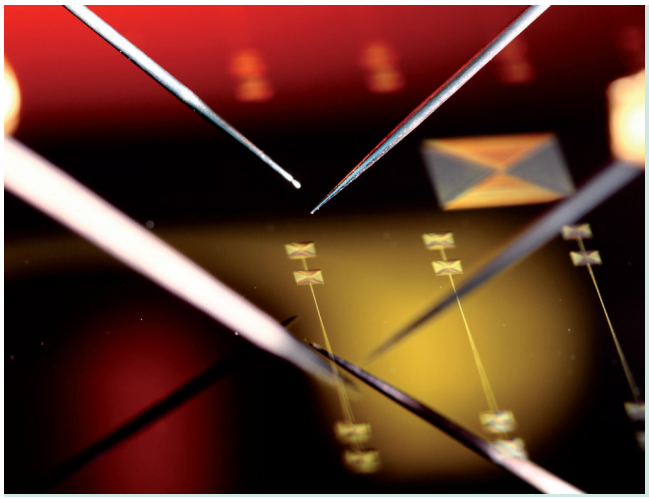
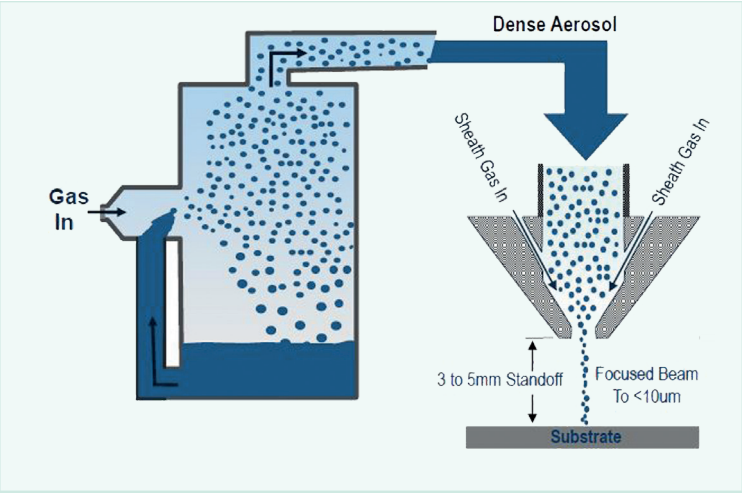
Description

Fraunhofer ENAS is working in the fields of MEMS packaging as well as chip and wafer bonding using high-tech cleanroom conditions and micro and nanotechnology laboratories. To extend existing connecting and bonding technologies aerosol jet printing technologies are investigated. Next to the possibilities that are given with ink jet printing the aerosol jet technology has outstanding advantages. It is possible to perform a selective deposition process as an additive process including a wide variety of materials onto a wide variety of substrates without conventional masks or thin-film equipment. Using the focused material beam (several mm lengths) enables deposition on three-dimensional surfaces. Especially the deposition of electrical conductive materials enables the realization of electrical interconnects over topographic structures and surfaces. The aerosol jet system is capable to print fluid-like materials such as particle inks and paste-like fluids. To increase the conductivity of the deposited porous metal particles a selective laser sintering or conventional oven sintering could be applied. Additionally other materials like polymers, adhesives, etchants, ceramics and bio-related materials could be printed. With a combination of two different materials also multilayers or mixtures of certain materials could be printed. For instance an electrical path could be covered with a dielectric polymer and it is safe for corrosion. Furthermore after this insulation another electrical path could cross the layer below.

Technologies available

Aerosol Jet is a non-contact direct-writing technology which allows the deposition of various functional materials such as particle inks, polymers, etchants and paste like fluids. The process is based on the atomization of the inks to produce femtoliter-sized droplets which are guided by a focused jet stream onto the substrate. Within the deposition head, the aerosol is focused by a sheath gas flow and the resulting high velocity converging particle





stream is deposited onto the substrate creating features as small as 10 µm in size with a good and long-term stable adhesion. The maximum line width is around 200 µm and depends mainly on the tip size and the gas flow parameters. At least the velocity of the printing process is up to 200 mm/s. Therefore also complex designs could be printed within a reliable time.

Unique material mixing

By combination of both pneumatic atomizers, mixing of different materials becomes possible. With this unique mixing process, i.e. graded depositions of functional layers can lead to new applications. The mixing process itself is controlled by regulation of atomizer rate and impact exhaust rate at both pneumatic atomizers differently. Both aerosol flows are guided through a wye turnout before entering the deposition head.

Equipment specification

Description	Value	Unit
2 deposition heads, variable nozzle orifice	100 ... 300	µm
1 ultrasonic atomizer for low volume inks (inks viscosities)	1 ... 5	cP
2 pneumatic atomizers for high volume inks (inks viscosities); mixing of matierials by combining of both atomizers possible	1 ... 1000	cP
Printable line widths	10 ... 250	µm
Velocity	up to 200	mm/s
High distance printing for 3D devices	up to 5	mm
Post printing laser sintering	>700 mW IR laser (830 nm, Gallium Aluminum Arsenide)	
Motorized X, Y stage with high precision positioning (Motion Accuracy)	± 6	µm
Motorized Z-axis (Motion Accuracy)	± 6	µm
Heated plate including vacuum chuck	up to 300 x 300	mm²

Figures:
page 1: Aerosol Jet Printing of non planar silver nano particle based chip-2-board and chip-2-chip interconnects. Line width of printed interconnects was set to 25 µm.

page 2: Electrical characterization of sintered silver interconnects (left), Aerosol jet deposition process, by courtesy of Optomec Inc. (right)
Photo acknowledgments:
OPTOMEC, Fraunhofer ENAS

All information contained in this datasheet is preliminary and subject to change. Furthermore, the described systems, materials and processes are not commercial products.

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