Fabrication of miniaturized moulded interconnect devices by means of laser induced selective activation (LISA)

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Outline

- Background
- LISA process
 - Process description
 - Characteristics
 - Performance of structures
 - Characterisation
 - Modelling
- Summary

Moulded Interconnect Devices (MID)

`.. an injection moulded thermoplastic substrate

which incorporates a conductive circuit pattern,

and integrates mechanical and electrical functions.."



Polymer components with metal "circuits" made by "hot-stamping"

Source: Krauss-Maffei



Moulded interconnect devices (MIDs) Industrial examples





Overview of MID processes and process chains



Main Steps of The LISA Process







Laser process characteristics (selected)

- PE, PP, ABS, PET/PBT, PC...
- Sample is submerged in distilled water

Laser type	Wavelength	Average power	Pass	Frequency
Nd:YAG laser	1064 nm	~3 W	15- 30	1.2-2KHz
UV laser	350 nm	~2 W	3-6	30-40KHz
Fibre laser	1075 nm	~10 W	1-15	1/2 - 3/4 *
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			Square pulse: Pulse- period ratio	



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Activation

Step1 Wetting

Step2 $PdCl_2/SnCl_2$ Activation $Pd^{2+} + Sn^{2+} \implies Pd^0 + Sn^{4+}$

Step3 Rinsing in distilled waterStep4 Rinsing in 10% HCl acidStep5 Rinsing in distilled water



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Metallization

- Auto-catalytic electroless copper bath
- Circuposit 3350 from Rohm Haas
- 45 Degree Celsius
- Rinse and dry the sample after plating
- Optional nickel + gold

$Cu^{2+} + 2 H_2CO + 4 OH^- \implies Cu^0 + H_2(g) + 2 H_2O + 2 HCOO^-$



Metallization





Plating velocity compared to LDS®

	LISA	LDS®
Plating time*	0.5hour	0.5hour
Activity of the bath**	1262s	900s-1200s
Substrate material	Polycarbonate 10% glass fiber	LCP
Temperature	52°C	52°C
Average thickness***	4.81µm	~2µm

* Electroless autocatalytic copper bath: Circuposit 4500 from Rohm and Haas
** e-Cu: Check system by HSG-IMAT Long time -> low activity.
*** The thickness is measured by Fischerscope® X-Ray system



Conventional plating processes







Samples —multiple metal layers





Adhesion test @ HSG-IMAT





PC +10% glass fiber

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Adhesion test @ HSG-IMAT



PC +10% glass fiber



Adhesion test @ HSG-IMAT

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	Average	Average adhesion	Standard
	power	strength (MPa)	deviation(MPa)
Group 1	4.2W	13.2*	2.9
Group 2	2.7W	13.0	2.1
Group 3	0.7W	11.7	1.6





Application – Dipole antenna



LISA

PCB

Application – Dipole antenna





Characterization of structures











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Bearing area curve – describing the structure



- Quantitative characterization
- •Peak, core and valley
- •Core structure determines the plating



Bearing area curve for five cases



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Normalization



Modelling approach

• Estimation of penetration depth as a function of temperature and energy input









Modelling approach

• Validation of mode - temperaturel



Modelling approach

• Validation of model – penetration depth



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Comparison with alternative processes

	LDS®	MIPTEC®	Full-Metallization	LISA
Materials	Special filler in materials, only a few materials are available	Thermoplastics and ceramics	Several thermoplastics are available for metallization	Standard polymers that absorb laser energy
Laser or other equip ment	Special wavelength to crack the bonds, special laser head to shape the track	Special wavelength to remove the metal layer	Special wavelength to remove the metal layer	Most industrial lasers
Wet step	Electroless plating	Electroplating and metal etching after sputtering	Dangerous chemicals for the pre- treatment	Activation and electroless plating



Thank you for your attention!

