

Inkjet Printing of Benzocyclobutene-based Inks

Filippo Iervolino^a, Raffaella Suriano^a, Martina Scolari^b, Ilaria Gelmi^b, Laura Castldi^b and Marinella Levi^a

^A Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy ^B STMicroelectronics, Via Camillo Olivetti 2, 20864 Agrate Brianza, Italy

Abstract

Polymer adhesives can be used in the electronic industry for wafer bonding and 3D integration. Benzocyclobutene (BCB) is a very interesting material thanks to its excellent bonding and dielectric properties. Usually, BCB is applied by spin-coating. However, to obtain complex patterns it is necessary to use a printing technology, such as inkjet printing. Here, we propose a study on the inkjet printing of BCB-based inks. We show the inks, the jetting and the printed patterns characterization. Finally, we prove the feasibility of printing complex patterns.

Introduction



Substrate Motion

INKJET PRINTING

BENZOCYCLOBUTENE

Benzocyclobutene (BCB) is a

and MEMS [2]

thermoset polymer adhesive with

planarization. Its main applications

are wafer bonding, 3D integration

low dielectric constant and good

Inkjet printing (IJP) is an **additive** manufacturing technology. It is a drop-on-demand system (selective

Methodology

Three types of inks are used in this work: BCB-mesitylene (MES) commercial solution (Cyclotene), diluted BCB/MES ink and **BCB/MES-dipropylene glycol dimethyl ether (DPGDME) ink**

Ink formulation &

Ceradrop 3D printer

ejection and deposition of drops) [1]

characterization.

Dimatix IJP cartridge

Jetting assessment

100 μm 5 m/s

Patterns printing & characterization





Results

INK & JETTING CHARACTERIZATION

Ink	BCB wt. %	MES wt.%	DPGDME wt.%
Cyclotene	48	52	0
BCB/MES	25	75	0
BCB/MES-DPGDME	25	28	47

PATTERNS PRINTING & CHARACTERIZATION

Simple patterns



We vs. Z printability diagram



> Drop ejection timelaps





 $Re = \frac{\nu \rho D_n}{2}$

Re

 \sqrt{We}

We = -

V: speed

D_n: nozzle

diameter

 $v^2 \rho D_n$

 $/\gamma \rho D_n$

 ρ : viscosity

 γ : surface

tension





120

BCB/MES (a) and BCB/MES-DPGDME drop & square patterns

Complex patterns



Ę 1.25 1.000.00 1.50 0.25 0.75 Length (mm)

Profilometry on BCB/MES square patterns

> **DPGDME** leads to **coffee ring effect**

BCB/MES ink shows a **better morphology**

BCB/MES ink allows printing complex features [3]



Printability diagram shows an ideal ejection speed of 5 **m/s** for the BCB/MES and **BCB/MES-DPGDME** inks

Formation of **satellite drops** at 7 m/s is shown [3]

Future works

 \succ Print patterns with larger dimensions (8")

- Characterize the bonding strength of the printed patterns
- Print BCB-based inks using aerosol jet printing
- Compare inkjet ad aerosol jet printing





References

Contact info

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[2] Forsberg et al., A comparative study of the bonding energy in adhesive wafer bonding, J. Micromech. Microeng (2013) [3] Iervolino et al., Inkjet Printing of a Benzocyclobutene-Based Polymer as a Low-k Material for Electronic Applications, ACS Omega (2021)

Filippo Iervolino filippo.iervolino@polimi.it



