Automated patterning of Nanocarbons inks using magnetic Micro Contact printing

Aude Delagarde[a,b,c], Lin Yang[a,b,d], Jean-Christophe Cau[f], Emmanuel Flahaut[a,b], Christophe Vieu[a,e]
[a] CNRS, LAAS, 7 avenue du colonel Roche, F-31400 Toulouse, France
[b] CNRS, Institut Carnot Cirimat, F-31062 Toulouse, France
[c] Univ de Toulouse, INP, LAAS, F-31400 Toulouse, France
[d] Univ de Toulouse, UPS, LAAS, F-31400 Toulouse, France
[e] Univ de Toulouse, INSA, LAAS, F-31400 Toulouse, France
[f] Innopsys, F-3190 Carbonne, France
aude.delagarde@laas.fr, j-cau@innopsys.fr

Nanocarbon micropattern integration into sensing devices is a key technology for various applicative fields in flexible electronics and wearable sensors. In this paper, we demonstrate that an automated micro contact printing (µCP) process can be implemented on a commercial system to generate nanocarbons (few layer graphene and carbon nanotubes) micropatterns.

Basically, µCP consists in the use of a micro-patterned polydimethylsiloxane (PDMS) stamp, which is inked by the molecules of interest. This inked and dried PDMS stamp is then gently brought into contact with a substrate and transfer patterns of the molecules of the ink adsorbed at the stamp surface. The conventional inking method for µCP consists in incubation of the inking solution onto the PDMS stamp [1]. When such a method is employed for nanocarbon containing inks, the resulting patterns exhibit severe defects related to the poor homogeneity of the nanocarbon film adsorbed at the stamp surface. To improve the printing process of nanocarbon inks, we have previously proposed to ink the PDMS stamp by spray coating an aqueous suspension of nanocarbons materials on an activated hydrophilic micro-patterned PDMS stamps (**Figure A**, 1) [2]. In this paper we extend this methodology by demonstrating that it can be implemented at an industrial level, using an automated printing tool (Innostamp40) which combines inking by spray coating and solvent and temperature assisted transfer printing using magnetically manipulated PDMS stamps [3].

Aqueous nanocarbons inks were prepared either with few layers graphene (FLG), or carbon nanotubes (CNTs) and carboxymethyl cellulose was added to improve the dispersion and stabilize the inks. After inking a magnetic stamp by spray coating, we performed µCP with solvent (Ethanol) mediation using an automated micro-contact printer: the Innostamp40 (**Figure A**, 2 left). The automated head, which contains magnets, was programmed to pick up an inked magnetic PDMS stamp, dispense a controlled volume of solvent (22 µL) on the receiving substrate, align the stamp, contact the surface and release the stamp. The substrate was heated (45 to 90°C) during 10 to 20 min in order to improve the transfer.
Using the Innostamp40 for µCP with solvent mediation, we managed to generate at low cost reproducible micropatterns of FLG and CNTs (**Figure B**) with a good alignment and on a wide range of substrates, including flexible ones. The whole process and the results will be detailed during the conference.

References

[1] J. L. Wilbur, A. Kumar, E. Kim, and G. M. Whitesides, Adv. Mater., vol. 6, no. 7–8, (1994) 600–604.
[2] A. Béduer, F. Seichepine, E. Flahaut, and C. Vieu, Microelectron. Eng., vol. 97 (2012) 301–305.
[3] J.-C. Cau, L. Lafforgue, M. Nogues, A. Lagraulet, and V. Paveau, Microelectron. Eng., vol. 110 (2013) 207–214.

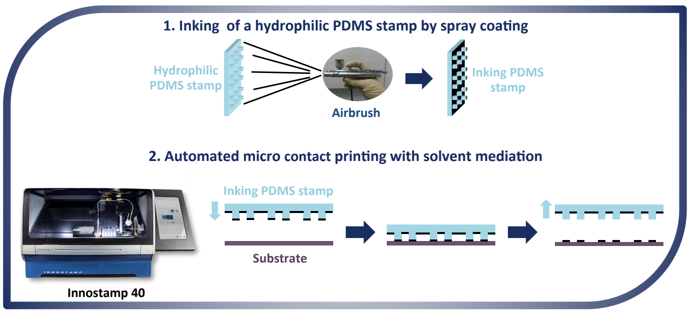

Figure A: Scheme of 1) the process of spray coating using an airbrush system, 2) on the left: pictures of an Innostamp 40, on the right: process for automated micro contact printing with solvent mediation.

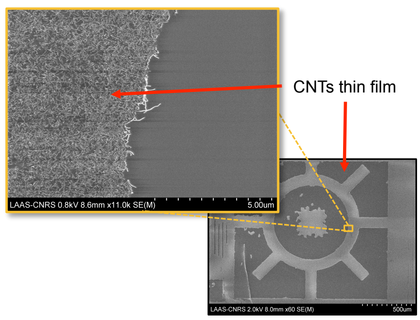

Figure B: SEM pictures of CNTs thin films pattern on a glass slide, printed by Innostamp40.