Flip Chip Lamination approach to fabricate ultrasmooth metal contacts for organic-based electronic devices

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Organic materials are highly attractive as active components in electronics for many technological applications such as next generation memory and logic devices, organic photovoltaics, organic field-effect transistors or biosensors. The great variety of molecular structures enables the tailoring of the electrical properties and ultimately, the ability to tune the device for enhanced performance. Successful application of these devices requires research on a reliable process to overcome the problems associated with the fabrication of top metal electrodes since conventional evaporation degrades the organic material. Flip Chip Lamination (FCL) is a novel fabrication approach based on nanotransfer printing that can help overcome these drawbacks[1]. We have successfully demonstrated for the first time the use of this technique in the fabrication of molecular electronic devices, and subsequently used it for a variety of other systems. For the molecular devices, we have examined the formation of silicon-based molecular electronic structures by first forming a highly ordered monolayer on an ultrasmooth flexible metal surface that can be subsequently bonded to the silicon substrate. Using polarized backside reflection absorption infrared spectroscopy (pb-RAIRS) we were able to study the geometry, chemical, and conformational changes at the interfaces and within the monolayers. Electrical characterization of the molecular junction has been also performed. We observed no metal penetration or molecular degradation after FCL. Further, we have implemented the lamination of metal contacts on other systems, such as organic single crystal field-effect transistors based on high quality rubrene crystals. Here, we have carefully tuned interfacial energies by means of chemical functionalization, pressure, and temperature to obtain a complete and continuous transfer on the organic crystal preserving its integrity.

[1] M.Coll, L.H. Miller, L.J. Richter, N.Gergel- Hackett, O. D. Jurchescu, C.A. Richter, C.A. Hacker, Journal of the American Chemical Society, *131* (34) **2009** 12451-12453.