Status and Challenges of Inkjet Printed RF and THz Structures

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***Abstract*— Inkjet printing is a low-cost, additive process that has enabled various disruptive technologies that combine new materials with novel multidisciplinary operation concepts. Beyond prototyping, their inherent scalability could make them good candidate for commercial/mass production applications such as large area structural monitoring, distributed sensing and IoT applications. This overview explores the reliability and the great potential of these novel technologies when applied to high performance RF and THz devices of the future.**

***Index Terms*— inkjet printing, additive manufacturing, RF, THz, modules, flexible electronics.**

I. Introduction

Inkjet printing has supported a wide range of applications ranging from flexible electronics and nanostructures to microfluidics and energy harvesting devices (Fig. 1). The use of this technology for RF and microwave applications began with the characterization of substrate material properties and complex impedance values at RF frequencies as a first proof-of-concept operation capability. Afterwards, the ability of inkjet printing to realize complete hybrid systems was demonstrated by the first complete wireless sensor modules in [1]. This was a fundamental step in demonstrating that mounted components performed their correct functions when integrated with flexible materials. The repeatability, reliability and dynamic bending/rolling performance of this technology as well as other printing technologies was tested in [2], realizing a major step towards the development of an assembly process for advanced performance operation. Right now, the integration level of inkjet printing technology is increasing with the development of 2D/3D interconnects, homogeneous 3D modules and multi-material/multilayer modules [3] that will eventually lead to drastically mineaturized multifunctional entirely-printed wireless devices and modules.

II. Reliability of Inkjet Printing Technology

Reliability has always been a major concern for inkjet printed structures, especially for High-Frequency Applications. To verify the performance of such printed topologies to be utilized on conformal or wearable platforms, the flexibility of the printed interconnects and the adhesion of the components to the printed films were tested. This was done by performing extensive bending tests on hybrid inkjet printed/rigid component low density layouts with minimum layers and a wide range of component sizes (Fig. 2). It was found that the silver-nanoparticle printing method demonstrated good adhesion properties, but leaving room for improvement in comparison to that of other methods such as the two-step electroless copper deposition method.

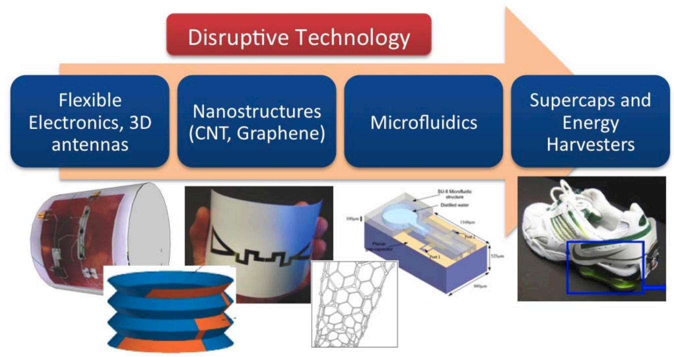

Fig. 1: Inkjet Printing enabled disruptive technologies.

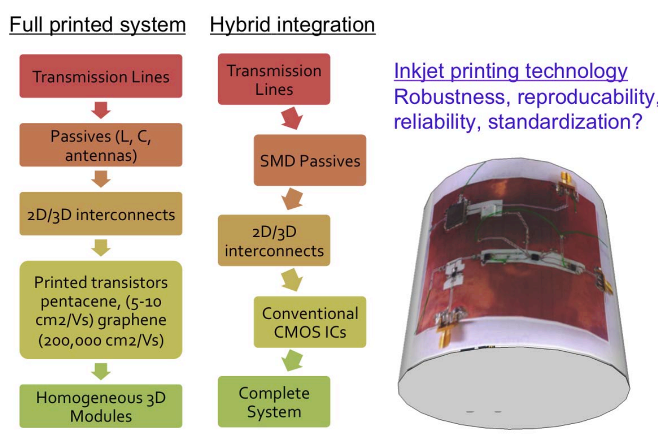

Fig. 2: Integration levels of inkjet printing technology.

III. Conclusion

There is a wide range of opportunities in inkjet printing technology. The advancement of this fabrication process to a fully printable system will be a major technological step that will allow the integration of devices into everyday life through mineaturization, portability, wearability, biocompatibility and environmentally friendliness.

REFERENCES

[1] R. J. Vyas, A. Rida, L. Yang, and M. M. Tentzeris, Design and Development of the First Entirely Paper-Based Wireless Sensor Module, System, pp. 13051308, 2008.

[2] A. Traille, A. Coustou, H. Aubert, S. Kim, and M. M. Tentzeris, Conformal/Rollable Monolithic Miniaturized Ultra-Portable Ground Penetrating Radar Using Additive and Inkjet Printing, in *International Microwave Symposium*, 2014.

[3] B. S. Cook, T. Le, S. Palacios, a Traille, and M. M. Tentzeris, Only Skin Deep, IEEE Microw. Mag., no. April, pp. 103114, 2013.