WFB (IMS) Friday 08:00 – 17:00 BCEC Room 152

Modern RFID: Inkjet Printing of "Green" RFID and RFID-enabled Sensors on Flexible Substrates

Full-day workshop reviewed by IMS09, MTT-16, MTT-20

Organizer(s):

Manos Tentzeris, GEDC/ECE, Georgia Tech; IMS TPC.
Amin Rida, GEDC/ECE, Georgia Tech.
Jan Sumerel, Fujifilm Dimatix.

This workshop presents a step-by-step discussion of the design and development of RFID and RFID-enabled sensors on flexible low-cost substrates for the UHF band and up to microwave frequencies. Various examples of fully function building blocks (design and fabrication of antennas, integration with ICs and microcontrollers, power sources, as well as ink-jet printing techniques) demonstrate the revolutionary effect of this approach in low-cost RFID and RFID-enabled sensors fields. The first part of the workshop will demonstrate the state-of-the-art inkjet printing techniques focusing on the novelty of digital printing, next generation and mass production of inkjet printing while giving several examples and guidelines. The second part will focus on the "first green RFID-enabled sensor", battery-less long-range RFID modules, and current problems in design/measurements of RFID-enabled sensors that make extensive use of power scavengers of renewable energy sources.

Speakers:

1. Paul Calvert, University of Massachusetts-Dartmouth, USA
"Reactive Inkjet Printing of Electronic Materials"

Inkjet printing can be used to deliver dots, lines and areas of material with a lateral resolution of about 100 microns and a thickness resolution of about 100 nm. By printing different materials sequentially it should be possible to build complex electronic or medical devices. Just as semiconductor manufacturing can draw on a wide range of materials and methods to make every-more complex structures, so we need to develop a palette of materials and methods to allow us to inkjet print new families of devices that incorporate metals, semiconductors, dielectrics and possibly biological molecules and cells. This talk will summarize our efforts to print metals and conducting polymers onto various substrates for antennas and sensors.

2. Amin Rida, GEDC/ECE Georgia Tech, Toyota TTC
"Modern RFID: Inkjet Printing of "Green" RFID & RFID Enabled Sensors on Flexible Substrates Conductive Ink-Jet Printed Antennas & Passives on Flexible Organics for RFID & WSN"

Various examples of ink-jet printed antennas on flexible paper and organic substrates will be discussed with an emphasis to Wireless sensor networks. The properties of the conductive inks, as well as potential ways to inkjet print sensors will be covered for "global-operability" UHF RFID-enabled sensors.

3. Dimitrios Anagnostou, South Dakota School of Mines and Technology, Rapid City, USA
“Green” Antennas Beyond RFIDs”

RFID tags and paper electronics are emerging technologies in today's industry. We focus on the exploration of the less developed areas of direct-write RF electronics on paper and organic substrates. We will go step-by-step through the design and direct-write fabrication technological issues of "Green" high-frequency antennas at frequencies beyond 0.9MHz and for a variety of applications. We define "Green" both as an environmentally-friendly organic substrate, and as a generic term that covers the ink and substrate fabrication, the ambient, cold deposition workplace, the low curing temperatures and the minimization of chemicals. All these allow the exploitation of the advantages of materials that cannot be co-fired. Using our "Green" technology, we show the monolithic fabrication of multilayer antennas and embedded microwave structures. Examples will demonstrate the impressive potential of direct-write technology when used in conjunction with sophisticated applied EM designs.

4. Li Yang, Georgia Institute of Technology, Atlanta, USA
“Green” RFID-Enabled Wearable Sensors”

In this presentation, we will cover inkjet-printed sensors on flexible organic substrates that combine miniaturized antennas, wideband matching and biomonitoring snesors. Special attention will be paid to the wearable limitations (easy-to-conform, proximity to human body). Various examples introducing high-efficiency vibration/heat scavengers will be discussed in detail in terms of power efficiency and lifetime.

5. Edward Gebara, Georgia Institute of Technology, Atlanta, USA
“Anti-Counterfeit Technology for RFID Applications”

With the ease of marketing products on-line, it seems that selling counterfeit objects has never been easier. Industries under attack include the software and the hardware, the pharmaceutical, the entertainment, and the fashion industry. Consequently, there exists demand for technologies that can either resolve these problems or significantly reduce the breadth of the search space for origins of counterfeits. This talk proposes an anti-counterfeiting technology that constructs a certificate of authenticity (COA) using a random hard-to-copy object whose multidimensional features are cryptographically signed to ensure reliable and convenient authentication.

6. Tohru Asami, The University of Tokyo, Bunkyo-ku, Japan
“Toward Energy Harvesting for Wireless Sensor Networks”

The wireless sensor networks is actively studied as a real space information acquisition system in ubiquitous society. In case that sensor nodes may be scattered in an environment and operated for a long period, reservation of a power supply is a critical problem. In this research, we propose to exploit RF signals in order to supply sensor nodes with power. There are many kinds of RF signals in our life space, such as TV broadcasting, radio broadcasting, mobile communication, wireless

LAN. But some of these signals are left unused and finally turn into heat. Our purpose is to reproduce electric power from these unused signals. Experimental results show that it is feasible to get enough energy to operate a sensor node within the range of 1km from Tokyo Tower.

7. Leila Deravi, Vanderbilt University
“Progress Towards Inkjet Printed Metal Particle Films as Potential Memory Storage Devices”

The electrochemical properties of printed gold monolayer protected clusters (Au-MPCs) have been investigated using a scanning electrochemical microscope (SECM). At room-temperature, MPCs exhibit a quantized charging effect, where electrons can be shuttled into and out of the Au core in the presence of an applied potential. Because this electron shuttling can be activated, MPCs have been studied extensively as redox active molecules and have been adapted to a number of specific applications. In this study, the room-temperature synthesis of printed MPC films is discussed, focusing specifically on ink design, printing optimization, and pattern characterization. The capability of the inkjet patterns to store opposite charges has been tested using the SECM in the presence of two independent redox mediating solutions, and the magnitude of current generated at the spot surface is shown to be a function of both the redox mediating solution, itself, and the number of printing cycles.