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Improving the resolution and conductivity of screen printed silver conductors

Xiao, George; Lang, Stephen; Tao, Ye

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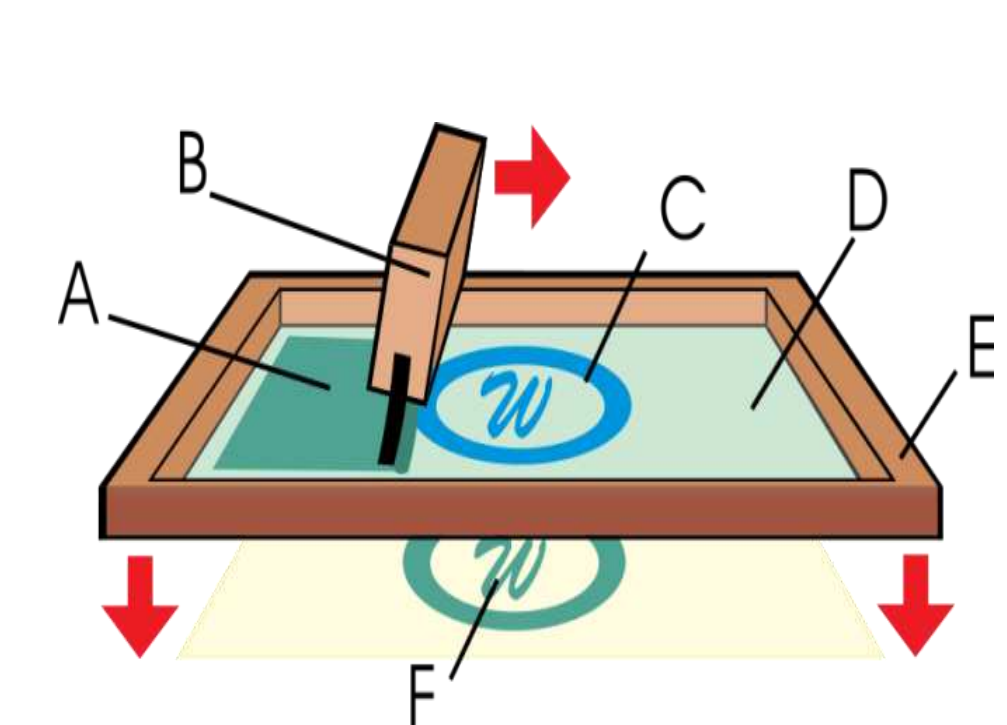
Improving the Conductivity and Resolution of Screen Printed Silver Conductors

ABSTRACT

Screen printing is the most widely employed printing technology in printed electronics. How to improve the conductivity and the resolution of screen printed silver conductors, which are the basis of the majority of printed devices, is presented in this poster. NRC has developed technology to overcome the conductivity and resolution issues for several printed electronics applications.

INTRODUCTION

Screen printing [1] is commonly used for the printing of artwork by both amateurs and professional printing houses. Its history can be dated back to more than 1000 years ago. The working principle of screen printing is very simple and straightforward as illustrated in Fig. 1. During operation, a flood blade is first moved across the screen to fill the open mesh areas (or artwork) with ink, and then a squeegee is moved in the reverse direction to force the ink trapped inside the mesh apertures into contact with the substrate surface. As the squeegee blade passes, the screen springs back from the substrate, and forces of adhesion between the ink and the substrate pull the ink out of the apertures in the mesh.



A. Ink. B. Squeegee. C. Image. D. Photo-emulsion. E. Screen. F. Printed image.
Fig. 1 Illustration of the operation of screen printing [1]



Fig. 2 Picture of the screen printer employed in this work

Screen printing is very versatile. It can be used for printing images on almost any solid material, such as paper, textiles, plastics, ceramics, wood, glass, metal etc. Fig. 2 shows a picture of the screen printer used by the National Research Council of Canada (NRC). The equipment has been used for the printing of HF RFID tag antennas, UHF RFID reader antennas, frequency selective surfaces, electroluminescent lamps, transistor electrodes, solar cells and memory. For many of these applications, high conductivity and high resolution are the two basic requirements for the printed conductors comprising the printed devices..

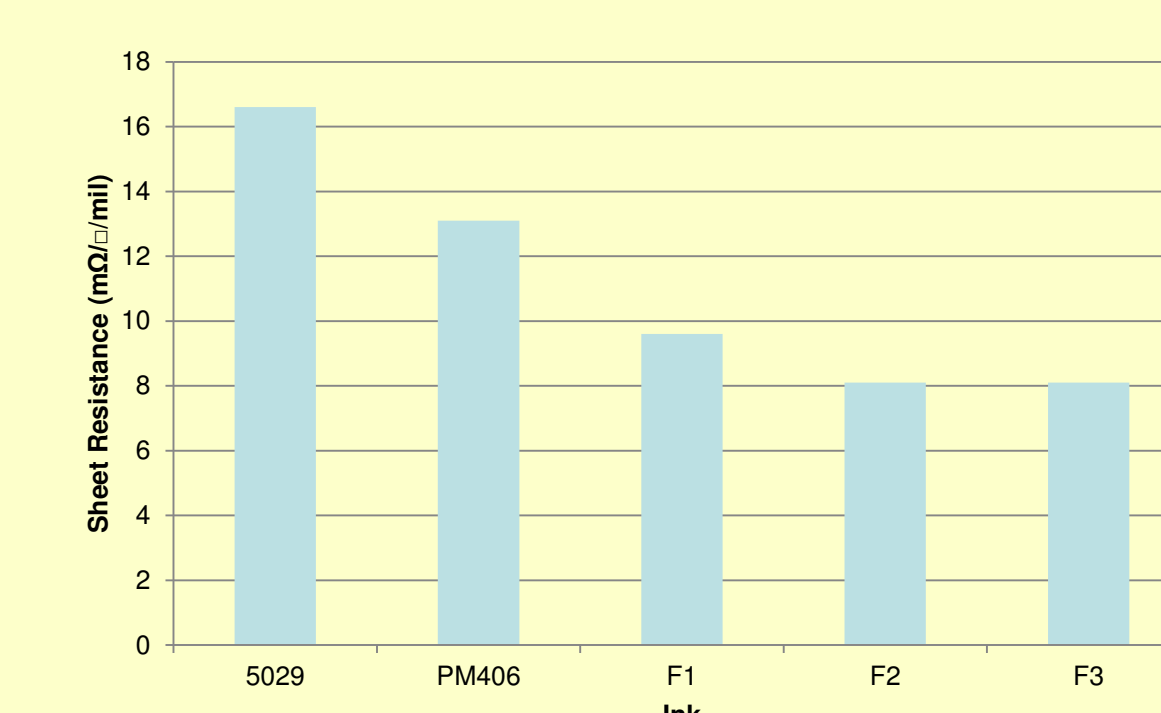
At NRC, we have established methods to screen print electrically conductive patterns with both high conductivity and high resolution. The capabilities developed and some of their applications are presented in this poster.

PARAMETERS AFFECTING THE PERFORMANCES OF SCREEN PRINTED DEVICES

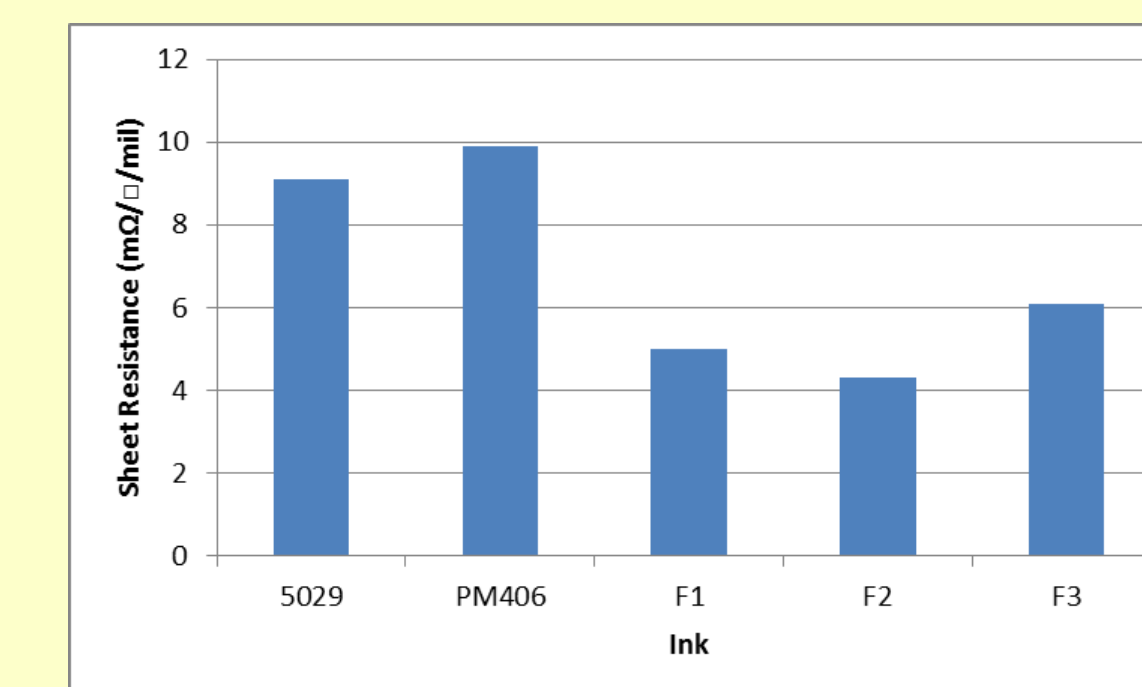
- **Printing Parameters:**
 - **Mesh Screen**
 - Material
 - Mesh count
 - Mesh tension
 - Wire orientation
 - Wire dimension
 - **Printer**
 - Squeegee material and hardness
 - Attack angle
 - Squeegee speed
 - Squeegee pressure
 - Snap off
 - Registration control
- **Material Parameters:**
 - **Substrates**
 - Polymer: PET, Teslin, PC etc.
 - Concrete
 - Paper
 - Composites
 - **Inks**
 - Conductive: silver flake, nano silver, carbon
 - Semi-conductive
 - Dielectric
 - **Solvents**
 - **Encapsulants**
- **Printed devices post-processing parameters**

IMPROVING CONDUCTIVITY OF THE PRINTED CONDUCTORS

Approach 1: Smart formulation



Approach 2: Photonic curing



Approach 3: Thermal mechanical treatment of the printed devices [2]

Samples	Resistance (Ohms)	
	Standard condition	Thermal-mechanical treatment
Design 1	43.1	12.7
Design 2	41.4	14.6
Design 3	46.8	16.4
Design 4	32.8	11.3
Design 5	37.8	12.3

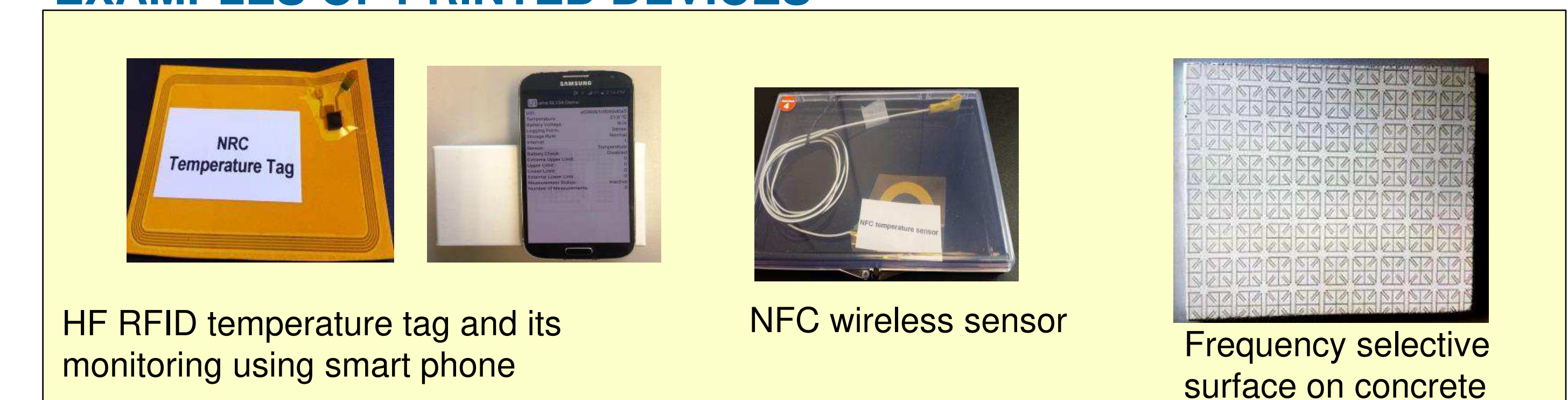
Table 1 Effect of thermal mechanical treatment on the resistance of HF RFID tag antennas printed on paper

HIGH RESOLUTION SCREEN PRINTING

Figure 3. Testing patterns.

Figure 4. Printed electrodes

EXAMPLES OF PRINTED DEVICES



CONCLUSION

NRC has developed the capabilities to fabricate silver conductors with high conductivity and high resolution.

REFERENCE

1. https://en.wikipedia.org/wiki/Screen_printing
2. G. Xiao, Z. Zhang, H. Fukutani and Y. Tao, "Properties of printed conductive tracks," US 20150129283 A1

OUR PARTNERS

