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Comparison of inkjet-printed silver conductors on different microsystem substrates

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ABSTRACT:

Applications for diagnostic and environmental point-of-need require processes and building blocks to add smart features to disposable biosensors on low-cost substrates. A novel method for producing such biosensors is printing electronics using additive technologies. This work contributes to the toolbox of processes, materials and components for printed electronics manufacturing - as well as rapid prototyping - of circuits. Printing protocols were developed to facilitate successful inkjet printing of nanosilver ink (Harima NPS-JL) onto different microsystem substrates using a functional printer (Dimatix DMP-3281). Photo paper is a standard inkjet substrate, which were compared with glass, polycarbonate (PC), plastic projector transparency foil, and polydimethylsiloxane (PDMS). Comparison attributes include physical and electrical properties. The layout design comprised dogbone elements of 8 mm length, and widths varying between 100 µm and 2 mm. All printed features were thermally cured for 1 hour at 120 °C. The physical characteristics were measured with a laser scanning microscope (Zeiss LSM-5) to determine the width, thickness and surface roughness of the printed features. An LCR meter (GW-Instek 8110) was used to measure the printed structures' electrical characteristics (resistance, capacitance and inductance). A lumped element model and layout design rules were extracted to assist in standardized design procedures. The model incorporates prediction of the bandwidth attainable with these structures. The layer thickness on all substrates is larger than the 1 µm on photo paper, and varies between 1.6 µm (PC) and 7 µm (PDMS). The spreading for PDMS is similar to photo paper, but since for the other substrates it is between 5 (glass) and 10 (PC) times larger than for photo paper, the layout

design rules require large spacing, leading to larger area networks. Electrical probing on the PDMS is not consistent and results are inconclusive. For the other substrates, the comparative dogbone resistance (100 µm width) is significantly larger than the 2 O standard, varying from 12.6 O (PC) to 19.3 O (glass). The bandwidth relative to photo paper is smaller by a factor of between 6 (PC) and 9.5 (glass).