# Can inkjet printing produce MRI coils?

**P. J. Smith[1], D. Mager[1], U. Loeffelmann[1], and J. G. Korvink[1]**
[1]Department of Microsystems Engineering, University of Freiburg, Freiburg, Baden-Wuerttemburg, Germany

In order for a structure to be suitable as a planar MRI coil, it should have a high conductivity (for low signal-to-noise ratio) and it must have a uniform cross-sectional area throughout the structure's length (to ensure predictable current distribution in the metal and be thicker than the skin depth at MR frequencies). To the knowledge of the authors, inkjet printing has not yet been used to produce MRI RF transmit and receive coils, possibly because of the variability of the fabrication technology, and the lack of low resistivity metal-containing inks.

However, inkjet printing's versatility has been successfully employed to produce a range of two- and three-dimensional structures from a variety of materials [1]. Its appeal lies in its additive nature, in that functional material is only deposited at the required location on the substrate. Therefore, the use of masks is eliminated and waste is greatly reduced; both of which lead to a financially appealing fabrication processes. Of particular interest is the fact a number of metal-containing inks have been inkjet-printed, with silver-containing inks being used mostly. Silver nanoparticle inks, i.e. a suspension of nanoparticles in a carrier solvent, are the main inks that have been used [2]. Although used less often, higher conductivities have been achieved with silver solutions [3], in which a silver compound is dissolved into a suitable solvent. This type of ink also has the advantage that it is easier to handle. A graph showing the change in resistivity as a function of curing temperature can be seen in Figure 1. The conversion process took only five minutes and samples that were treated at temperatures of 150 °C with all curing time for all samples was 5 minutes with the dashed line representing the resistivity of bulk silver. This demonstrates that inkjet printing can quickly produce features with high conductivity.

When a single-component ink is jetted onto a unstructured surface it has the tendency to deposit the majority of its solute at the boundary. This phenomenon can be rectified by the addition of a second solvent whose boiling point is higher than that of the main solvent [4]. Figure 2 shows the difference in morphology between films of a CdTe NC solution containing 1% wt PVA using either **a)** water or **b)** a water-ethylene glycol mixture (98/2 $^{v}/_{v}$) as the solvent. It can be seen that the solvent mixture in **b)** has produced the more uniform film. This demonstrates that by optimising the ink formulation, features with uniform cross-sectional areas can be produced by inkjet printing.

In this paper, we discuss the questions and responses facing an inkjet-based processing route for MRI coils, and report on the experimental steps that have been undertaken to demonstrate the veracity of the answers.

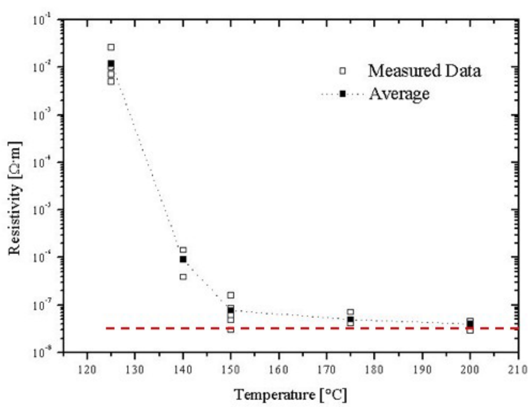


**Figure 1.** A graph displaying the resistivity of silver tracks, produced by inkjet printing, as function of temperature. The dotted line indicates the value of bulk silver. Each track was thermally treated for five minutes.

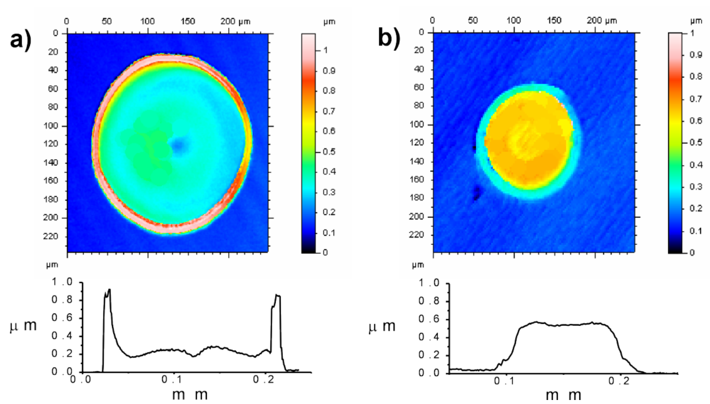


**Figure 2.** Two images obtained from white-light interferometry of aqueous CdTe droplets a) without ethylene glycol and b) with 2 vol% ethylene glycol.

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