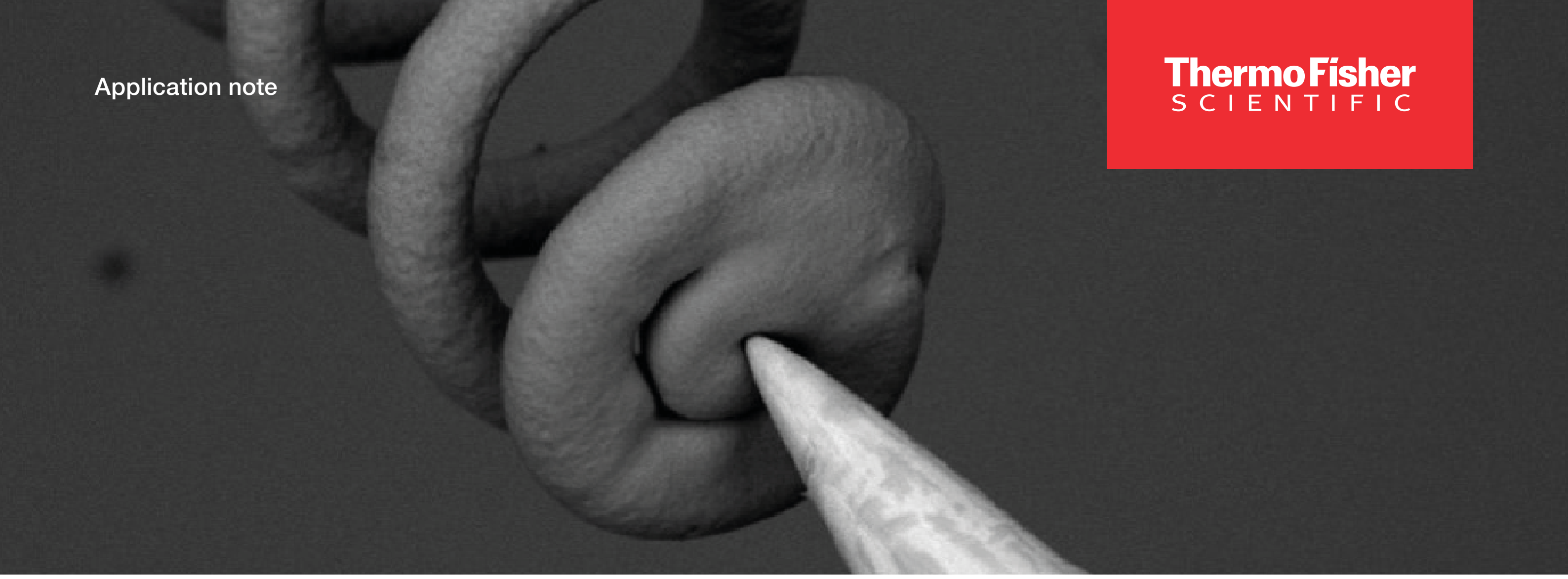
Application note



Manipulation and probing of 3D printed metal microsprings in a desktop SEM

Introduction

Micro-electromechanical systems (MEMS) and many other microscale electronic components require delicate manipulation and electrical probing. Analysis of these components is relevant in a number of areas from academic research to industrial-scale production and quality control. In all cases, it is often essential to obtain the best possible results in the shortest time. In this application note, Exaddon, Imina Technologies, and Thermo Fisher Scientific demonstrate a novel approach for microprobing inside a desktop scanning electron microscope (SEM) that can provide quick and precise characterization of microscale objects.

Materials and methods

Exaddon offers unique additive micromanufacturing (μAM) technology for the production of microscale components, including springs, with excellent material properties. Such microsprings have a variety of uses, including as contacts in probing arrays. The Exaddon CERES μAM System enables the printing of metal object, with complex geometries, directly on chip surfaces via localized electrodeposition. With this approach, each spring of an array can have a different number of turns, vertical spacing, and pitch. In this application note, the CERES μAM System was used to 3D print a microscale copper spring on a copper substrate. The resulting spring was 90 μm tall with a 10 μm radius; the diameter of the printed metal was less than 4 μm. A summary of the spring's physical properties and key dimensions is given in Table 1.

Height	90 μm
Radius	10 μm
Diameter of printed material	<4 μm
Number of turns	6
Vertical spacing between turns	15 μm
Voxels printed	1,128
Voxel printing time	512 s
Ink	Copper bright

Table 1. Key microspring dimensions.

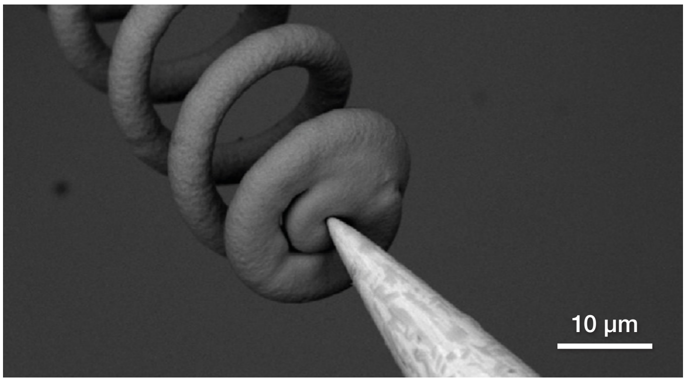


Figure 1. A microspring, printed by the Exaddon CERES μAM System, in contact with an Imina Technologies miBot Prober Tip. SEM image collected inside a Thermo Scientific Phenom XL G2 Desktop SEM.

In order to characterize its electrical and physical properties, the 3D-printed cooper microspring was loaded into a Thermo Scientific™ Phenom™ XL G2 Desktop SEM with an integrated, in situ electrical probing system from Imina Technologies. This setup consists of 3 Imina Technologies miBot™ Probers that are able to freely move over the base and are electrically connected to a control unit outside of the microscope. Electrical probing, data collection, and export is managed via Imina Technologies Precisio™ Software.

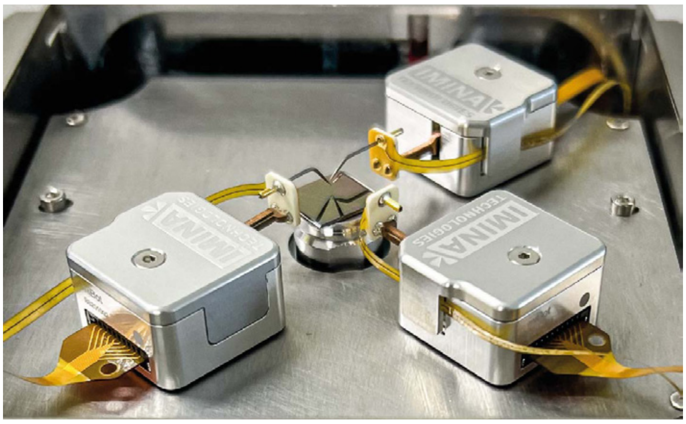


Figure 2. Imina Technologies miBot Probers placed around the Phenom sample holder.

The user-friendly motion control of the miBot Probers, along with the integrated optical navigation camera of the Phenom XL G2 Desktop SEM, helps to quickly locate and approach the sample. Fast imaging with 10-nm (or better) resolution allows the probers to land on the 15 µm contact area of the spring and to observe its deformation in real time.

To characterize the microspring, a miBot™ Prober tip was placed on the spring's contact area, while another prober tip was in contact with the substrate. I/V characteristics were then recorded as the first tip gradually compressed the microspring. This configuration easily measured the conductivity of the microspring and determined the deformation necessary to create a good electrical contact with the spring.

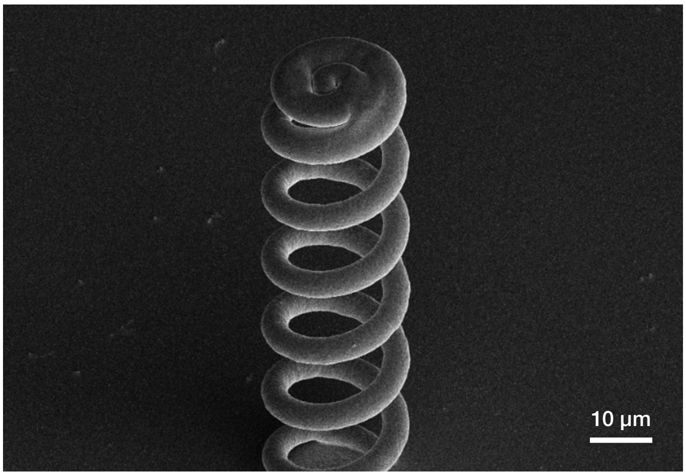


Figure 3. Microspring imaged with the Phenom XL G2 Desktop SEM.

Conclusions

This application note brought together the expertise of Exaddon, Imina Technologies, and Thermo Fisher Scientific for the production, characterization, and imaging of copper microsprings. Exaddon provided high-quality, 3D-printed microsprings, which were subsequently characterized with an in situ electrical probing solution from Imina Technologies. The experiment was conducted inside a Phenom XL G2 Desktop SEM, which enabled quick and straightforward navigation around the sample as well as high-resolution SEM imaging of the microsprings.

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