Application Note CI18

Performance Characterization of a Cryogenic Probe Station attoCPS I

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In a series of tests with the new released attocube systems probestation, Munich researchers have found significant benefits for their research of nano-electro-mechanical structures (NEMS) and related high frequency (HF) experiments.

In the basic version, the cryogenic probe station consists of four 3-axes positioning stacks (ANPxyz50/LT) allowing to position four probes independently onto a sample with high precision (max. sample diameter: 6 mm). The positioning can be monitored by a camera system. A picture and schematic drawings of the setup are shown in Figure 1. The probes can be placed within a center area of 4 x 4 mm^2 even at 4 K. The sample is fixed in the middle and a configurable optic allows imaging the center area.

In a series of tests at the Ludwig-Maximilians-University (LMU) in Munich, the positioning of the probes on the contact pads have proven to be extremly reliable and repeatable. Here, each probe consists of two tips (signal and ground), resulting in four ultra-compact HF probes. A series of more than 100 probe positionings showed identical contact resistance and no degradation of the contact pads! The contacting was proven to be a safe and reliable process.

Furthermore, a NEMS sample was tested for its HF characteristics. The sample consisted of nano-mechanical freely suspended Si-bars of 150 nm width, 6 µm length and 100 nm thickness with an additional 50 nm thick layer of Au on top. The Au-pads providing the contact had a size of 100 x 100 µm^2. The sample consisted of 20 identical structures, thus allowing for statistical *in-situ* studies. The results compared to conventional wire bonding are shown in Figure 2. The measured damping using the attoCPSx4 was as low as -2 dB at 4 K and 12 T. This is slighly more than achieved with conventional wire bonding. However, while bonded wires tend to vibrate in magnetic fields when a signal is applied (thus showing resonances), the test with the attocube probe station showed absolutely constant, undisturbed contacting. This is a major achievement, the Munich researchers say. The electro-magnetical excitation of the NEMS resonator for different magnetic fields is shown in Figure 3.

One of the major benefits of this probe station is the possibility to address all 20 structures at a temperature of 4 K while the field was engaged with 12 T. This allows comparing structures that have undergone identical processing. The process of warming up the system, renewing bonded wires, reassembly and cooling again was a time consuming and unreliable process in the past. Now, using the attocube probestation, testing of many structures within one cooling cycle at high magnetic fields is enabled.

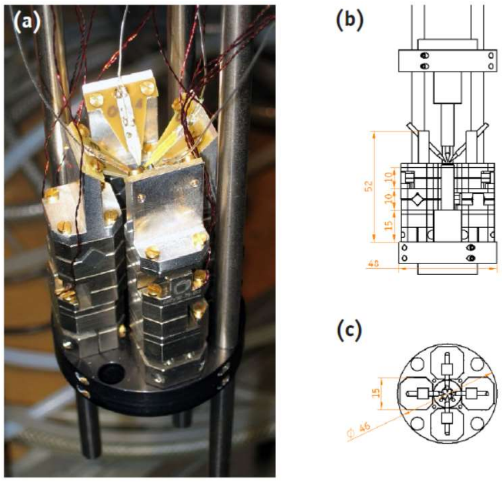

Figure 1: *(a) Picture of the cryogenic probe station attoCPSx4. (b) Side view showing the overall compact design. (c) Top view with four ANPxyz50 nanopositioning stacks controlling the measurement tips.*

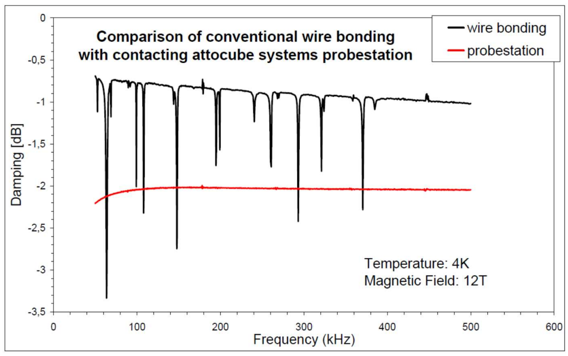

Figure 2: *Comparison of conventional wire bonding with attocube systems probe station attoCPSx4. Measurement conditions: 4 K, 12 T.*

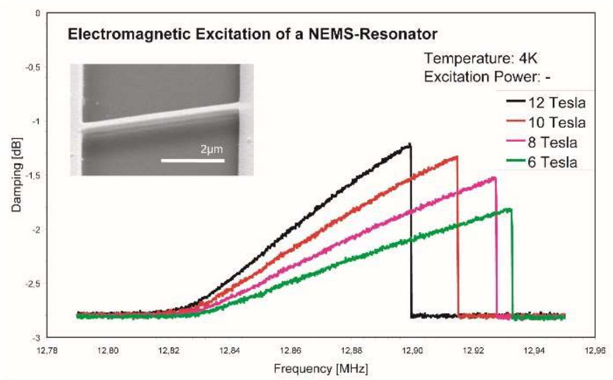

Figure 2: *Electromagnetic excitation of a NEMS resonator. Insert: SEM-picture of the resonator structure.*

(Sample, measurements and data courtesy of D. König, LMU Munich, Munich, Germany)