IMINA TECHNOLOGIES

TECHNICAL PAPER

FASTER AND SAFER PROBE LANDING

INTRODUCTION

Nanoprobers are usually driven by piezo actuators, operating in two distinct and complementary modes of motion:

• Coarse mode: stick-and-slip motion with step size of a few hundred nanometers [Figure 1]

• Fine mode: continuous motion, in the piezo range.

The coarse mode is used to quickly approach the region of interest. The fine mode is extremely precise, and therefore is used to land the probe on the sample.

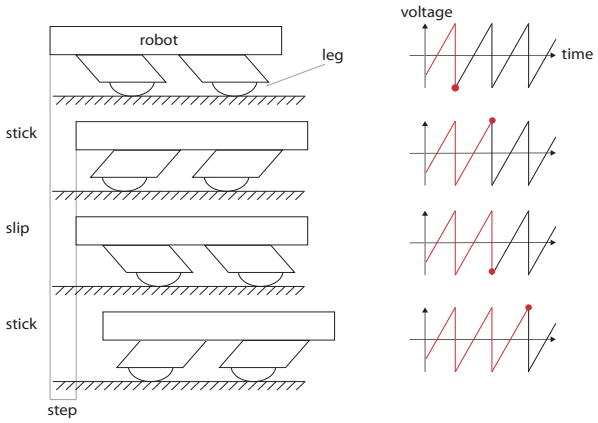


Figure 1. A schematic illustrating stick-and-slip motion: piezo actuators move forward each time voltage is applied to them, moving the probe along (stick). When the voltage is off, the actuators quickly contract, while the probe remains in place (slip). After that, the cycle can be repeated to make another step.

IMPORTANCE OF A LARGE RANGE OF FINE MOTION IN Z

When landing probes, the user must find balance between being fast and being safe. The ideal workflow is to use the coarse mode to bring the probe close enough to the sample surface and switch into the fine mode for further landing. This way, there is very little risk to damage the probe and the sample in the process.

What makes this process tedious and time-consuming is that one cannot precisely position the probe relative to the sample surface relying on the image from Scanning Electron Microscope (SEM). The reason for that is that the vertical resolution of an SEM is usually a few hundred nanometers and it depends on many factors such as imaging mode, beam current, etc., so it can vary a lot.

To avoid the collision between the probe and the sample, the user has to evaluate the distance between them by focusing on both and comparing the corresponding working distances. Usually the probe is brought in the fine-mode range (usually in the micron range) in interations: the user focuses on the sample surface, then brings the probe close enough so it would be visible but not in focus using the coarse mode, then one can try to land the probe in the fine mode. If the probe-sample distance was not in the fine-mode range, the user has to retract the probe, make another step in the coarse mode, and try to land again. This procedure can be very time consuming.

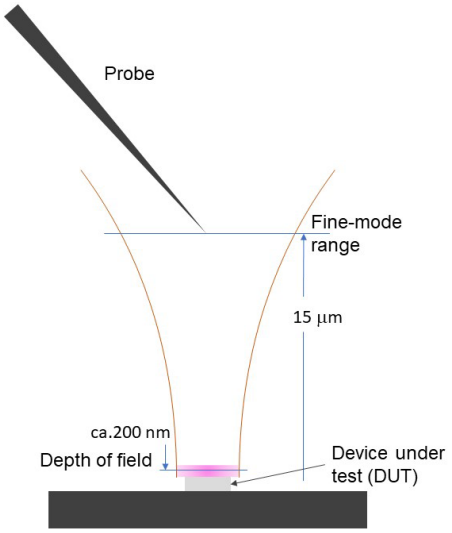


Figure 2. A schematic showing how extended fine-range compares to the depth of field, or to the point where the probe becomes visible, if the sample surface is in focus. Image not to scale.

INTRODUCING ROBOT NANO+: THE ULTIMATE SOLUTION FOR FAST AND SAFE PROBE LANDING

To answer this challenge and make probe landing faster and safer, we are releasing a new generation of our robots, the NANO+. The fine-mode range of NANO+ robots is extended to 15 µm.

In NANO+ workflow, the user can safely position a probe far away from the sample using the coarse mode. With plenty of range to land the probe, the fine mode can be used from there without the need for back-and-forth. NANO+ robots make nanoprobing a much easier, faster and safer task, especially under low acceleration voltage conditions for small technology nodes.

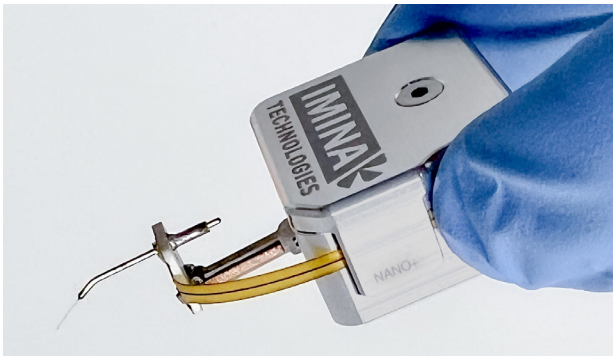


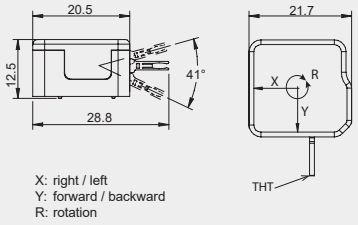
Figure 3. New Robot NANO+

Another benefit of extending the fine mode range is safer navigation around the sample when moving the probes from one feature to another. Some samples are not glued flat on the SEM stub, so they may be slightly tilted. A probe retracted by only a few hundred nanometers from the surface, could hit the surface when moving to the next location if that location is higher up because of the slope. With the fine mode range extended, the user can lift the probes much higher above the surface and move them safely over the sample, without spending too much time on landing them again.

Other specifications of new manipulators remain unchanged. The coarse mode and lateral motion are not affected by this modification. An upgraded version of Precisio™ software is delivered to control this new feature, and from the user's perspective there is almost no change between the software versions.

If you already use our NANO solution you can upgrade your probers to NANO+ and enjoy faster and safer probe landing.

Robot NANO+ specifications	
Degrees of freedom	4 independently driven (X, Y, R, Z) per prober
Dimensions & weight	Body: 20.5 x 21.7 x 12.5 mm³ Arm: 8.3 mm (without tool) Weight: 12 g (without tool)
Max. positioning resolution	Stepping (coarse): 60 nm (X, Y), 120 nm (Z) Scanning (fine): 0.02 nm (X, Y), 0.1 nm (Z)
Motion range	Stepping (X Y, R, Z): 20 x 20 mm², ± 180°, 41° Scanning (X Y Z): 250 x 440 x 15'000 nm³ *Note: in stepping, actual X, Y, R range are only limited by the size and shape of the stage where the robot moves, and the length of the driving cable.*
Speed	X and Y: up to 1.5 mm.s^{-1} Z: up to 150 mrad.s^{-1}
Forces & torques	X and Y: push: 0.3 N, hold: 0.2 N Z: lift: 0.7 mNm (5 g), hold: 0.9 mNm (6 g)
Tilt angle	Holding position up to 55°
Drift	< 1 nm/min



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