electrode size is as small as 100 nm in diameter that will allow for sub 100 nm topographical and current mapping resolutions.

Packaging for EENP:

To improve the electrical insulation of EENP, the EENP are mounted on a small ceramic chip holder as shows in ***Figure 2***. There is a copper coating at the middle of the ceramic chip holder where a wire is soldered to it (***Figure 2*** top row). The entire device is then covered by a non-conductive resin. This packaging also make the device handling easier and prevent the insulated later from scratch during the handling and insulations. ***Figure 2*** (bottom row) show optical images of the actual device as it is handled by twisters.

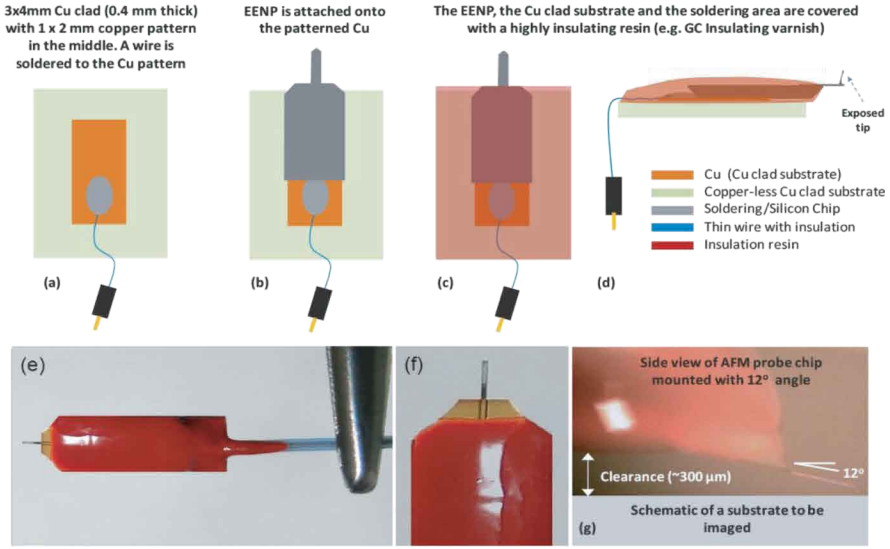

Figure 2. (a) A 3×4mm (0.4 mm thick) ceramic with 1×2 mm Cu pattern in the middle of the ceramic with a wire that is soldered to the Cu pattern. (b) The EENP is attached onto the patterned Cu. (c) The EENP, the Cu pattern, and the soldering area are covered with a highly insulating resin (e.g. GC Insulating varnish). (d) overall and (e) Side view of the device after applying the insulating resin.

Cyclic Voltammetry of EENP:

Figure 3-Left shows Cyclic Voltammetry (CV) on an EENP probe that was measured by immersion into a 5mM solution of $Ru(NH_3)_6Cl_3$ containing 0.1M $KClO_4$. An steady-state behavior is evidenced by the Faradaic current plateau. In this case the current approaches a diffusion-limited value of 700 pA. Repeating the experiment several time shows no change in CV curves that is the evidence for stability and robustness of the probes. Background currents before tip exposure is negligible (~5 pA).

Topographical and electrochemical images of a standard test substrate (gold patterns) are shown in ***Figure 3 (Middle and Right)***. The features on the gold patterns are well resolved in both the topographical and electrochemical images. The line scans through the cross-sections of topography shows sub-100 nm features in the gold patterns that are also observed in the electrochemical image. The probes were suitable for imaging over many hours.

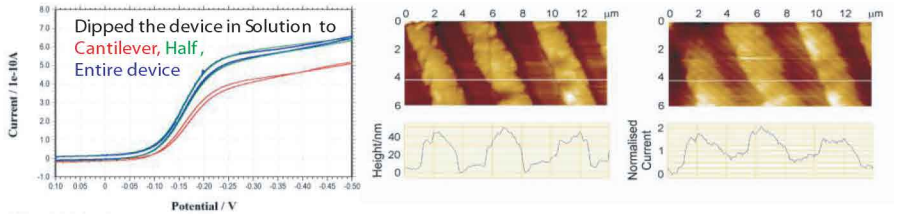

Figure 2: (a) The Cyclic Voltammetry of the EENP on 5mM $Ru(NH_3)_6Cl_3$ in 0.1M $KClO_4$ solution, Rate = 0.1 V/s, Sensitivity = 10^{-9} A/V. (middle) AFM topographical, and (right) electrochemical image. Current is normalized relative to the bulk current of 2 nA. AFM images are the Courtesy of Dr. Andy Wain, (National Physical Laboratory, UK)

Advantages of EENP:

- Negligible electrical leakage (sub 10 pA)
- Sub 100 nm resolution in electrochemical images can be achieved.
- Cylindrical shape electrode is ideal for electrical measurement
- Highly conductive
- Long shelf time
- Easy to handle

www.nauganeedles.com