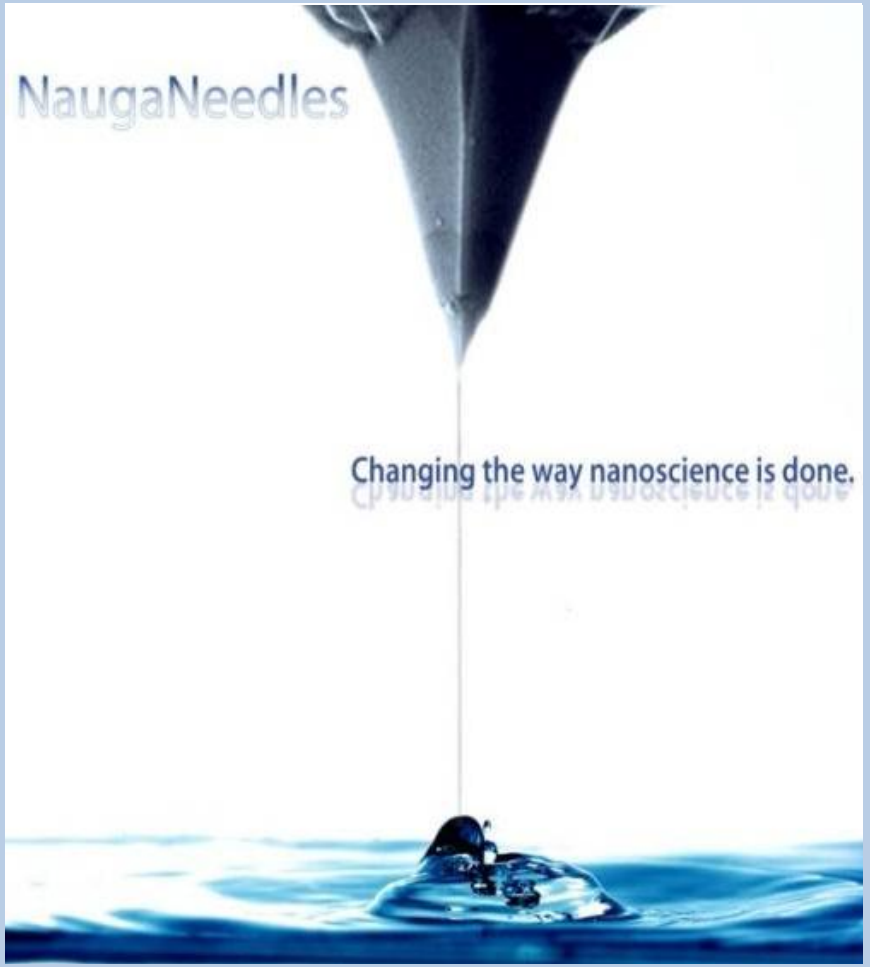

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NaugaNeedles' All Metal High Aspect Ratio NeedleProbes (HAR-NP)

NaugaNeedles offers high aspect ratio all metal Ag_2Ga NeedleProbes with cylindrical shape in wide range of length and thickness. (***Figure 1***). Silver gallium NeedleProbes can be grown on different substrates including AFM tipped and tipless cantilever, STM probes, quartz tuning forks.

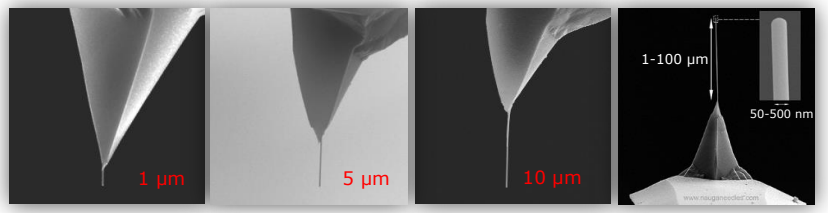

Figure 1 *SEM image of High Aspect Ratio Needle-Probes*

Examples of All Metal NeedleProbes Performance:
All metal NeedleProbes are used for variety of scanning probe microscopy applications including Kelvin Probe Force Microscopy (KPFM), Electric Force Microscopy (EFM), and surface potential characterization. Also, their high aspect ratio feature enable them to measure deep trenches, holes and samples with steep sidewalls where normal AFM tips with conical shape are incapable of.

KPFM: In one of the initial experiments using HAR-NP, scientists demonstrated how the tip geometry and conductivity enhanced the image resolution. In this particular case, they showed how KPFM has potential as a label free method to detect the protein-DNA interactions (the aptamer binding on protein pattern, ***Figure 2***). The experiment required to conduct topography, Phase and surface potential signals simultaneously during a scan. The KPFM method detects the contact potential difference (CPD) between a conducting AFM probe and the surface. Therefore there is a capacitance between the tip of the AFM probe and the surface directly under the tip, and also between the rest of the cantilever and the side planes of the probes. Basically a generic pyramid-shape tip has large capacitance between the tip side planes and the surface regions surrounding the tip, which yield a poor resolution, so in this case the tip is unable to resolve the aptamer-bound pattern edge. In contrast, the

capacitance between the tip's side planes and surfaces surrounding the tip for HAR-NP probes are minimized. ***Figure 2*** shows a representative tightly packed lysozyme pattern with anti-lysozyme aptamers bound on the pattern edge measured by HAR-NP and standard AFM tip.

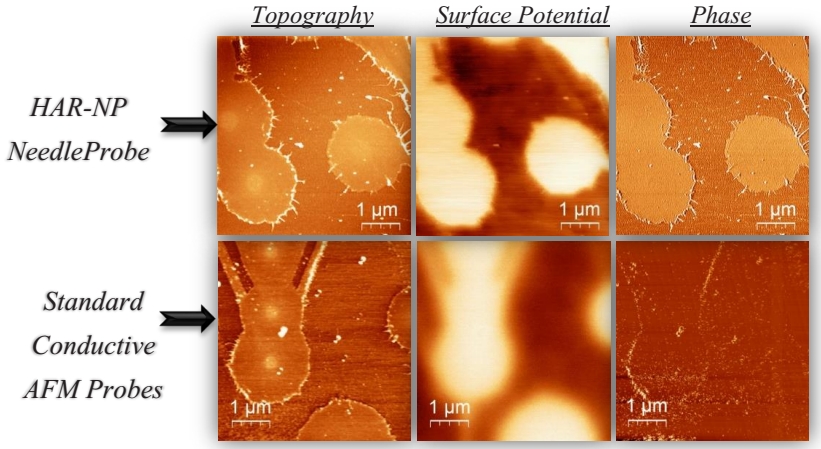

Figure 2 *The KPFM characterization of lysozyme patterns, Topography image. Surface potential image and Phase image.* Analytical and Bioanalytical Chemistry Vol. 394, Issue 1, (2009) 207-214

EFM: In another experiment, scientists applied Electric Force Microscopy (EFM) to conduct subsurface characterization of carbon nanotubes (CNT) in polymer composites. Geometry of the probe has been studied as one of the main effects on the EFM contrast. Compared to a conventional AFM probe, ***Figure 3(a)*** the tip cone of an HAR-NP probe, ***Figure 3(b)***, is more slender and longer. Enhanced EFM subsurface imaging on an SWCNT–polyimide film is achieved by an HAR-NP probe as shown in ***Figures 3(d)*** and ***(f)*** compared with EFM imaging in ***Figure 3(c)*** and ***(e)*** using standard probes. The cross-section analysis along the segmented line shows the peaks in ***Figure 3(f)*** are stronger and sharper than those in ***Figure 3(e)***, which indicates both enhanced EFM contrast and spatial resolution on subsurface imaging of SWCNTs by the HAR-NP probes. The non-local electrostatic interactions are greatly reduced by an HAR-NP tip due to its long and slender tip shape. That is why an HAR-NP probe can provide a stronger EFM signal as well as better spatial resolution than a conventional probe for subsurface imaging. The HAR-NP probes specs are listed below, ***Table 1***.

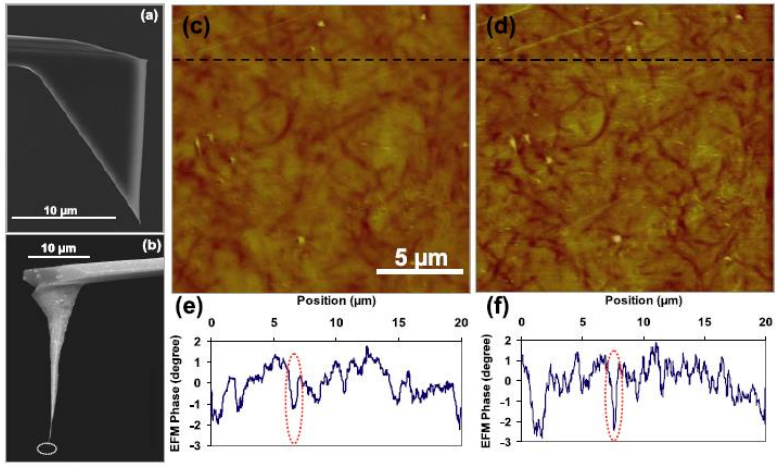

Figure 3*. Enhanced EFM subsurface imaging of 0.5% SWCNT (LA)–polyimide nanocomposite film using an HAR-NP probe and compare with standard AFM probes.* Nanotechnology 21 (2010) 225702

Table 1. *HAR-NP Probes specs*

Technical Data	Typical			Range		
Needle Material	Ag_2Ga			NA		
Needle Length	1 µm	5 µm	10 µm	0.5-3	4-7	7-12
Electrical resistance of tip and AFM cantilever	30 Ω	65 Ω	100 Ω	15-45	50-80	80-120
Tip radius	25 nm			20 -100 nm		
Needle Angle	12°			7°-15°		
Needles Electrical Resistivity	1.05×10^{-7} Ωm			$1 - 1.1\times10^{-7}$ Ωm		

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