Operation of Scanning Ion Conductance Microscopy (SICM) at Short Tip to Sample Distances

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Scanning ion conductance microscopy (SICM) provides a noninvasive imaging way to map surface topography for biological samples. It is operated by bringing a nanopipette, the scanning probe, close to a sample of interest to laterally and vertically scan over the sample to collect both ion current and topographic image. Ion current measured between an electrode inserted inside of a nanopipette versus an electrode placed into bulk electrolyte is collected as the control signal while probe scans. The assumption of the imaging mechanism is that ion current falls monotonically with decreasing the tip to sample distance. However, charge to charge interactions that happen between nanopipette and the scanned sample might affect the current signal as probe is brought close enough to the surface of interest. It is of great interest to investigate the interaction forces between a nanopipette to charged surface when probe and surface are in close proximity. Work presented here studies two related phenomena with respect to the working mechanism of SICM once probe to surface are brought within nanometer scale (1). how does ion current change as a nanopipette probe approaches or scans over charged substrates. (2) what are the possible driving forces that would affect the sign and magnitude of the ion current and thus further affect the image process.