Selective hydrogen ion beams from nano-structured emitters

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Hydrogen ion beams have been discussed as useful for scanning ion microscopy because of hydrogen's low mass and low sputtering rates. These systems rely on nanotip gas field ion sources (GFIS) to generate the hydrogen ion beam and the exact structure of the nanotip and the applied electric field are shown to be very important. It is demonstrated that hydrogen ion beams are found to occur as mixtures of H^+, H_2^+ and H_3^+ depending on the electric field strength and the nanotip structure. Various nanotips were prepared for comparison, including single atom tips (SATs), trimers and other nano-structured tips. The hydrogen beam contents were analyzed by separation using a magnetic field in order to compare the ratios of H^+, H_2^+ and H_3^+.

It was found that single atom tips produce primarily H_2^+ at low operating voltages, but as the voltage is increased, H_3^+ dominates and pure H_3^+ beams can be generated for a range of operating voltages. For the trimer case, H_2^+ becomes a significant species and equals the H_3^+ current but H_3^+ can be isolated at higher voltages. For the hexamer tip structure, H_2^+ almost completely dominates with little H_3^+ being produced.

Hydrogen ion beams prepared from W SATs and Ir SATs will also be compared. As well, global tip structure will be evaluated by comparing SATs prepared by various tip shaping methods, including, SATs prepared by anneal faceting and SATs prepared by field controlled etching techniques. Other parameter such as voltage and temperature affects are also discussed and operating constraints for single species ion beams will be determined.