Preparation and Characterization of Spin Polarized Tips for Tunneling Microscopy

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Most of the modern technologies rely on very tiny objects and, therefore, nanotechnology is currently very burgeoning area of research. A proper measurement of fundamental magnetic and electrical properties at the atomic level can be effectively accomplished by scanning tunneling microscopy (STM), where tungsten or platinum-iridium alloy tips are usually used to observe atomic structures. Unfortunately, these tips are generally unable to achieve magnetic contrast. This can be overcome by chromium tips but their production is hampered by the brittleness of chromium blank. These issues have motivated me to search other materials suitable for fabrication of spin-polarized tips. My work mostly focuses at improving the preparation of Mn88Ni12 alloy-based tips and verifying their magnetic properties. I have successfully realized a set-up for testing different conditions to prepare tips by electrochemical etching process. By optimizing the processing parameters, I have doubled the success rate of etching the tips and significantly facilitated their preparation in terms of shortening the processing time from the original 4–5 minutes to 15–20 seconds. A thorough analysis of different electrolytes and their effect on the quality of the tips was carried out. Based on more than hundred tests carried out, 10% hydrochloric acid was chosen as the best electrolyte. In addition, the spin-polarized STM experiment on Co nanoislands revealed the best tips as spin-polarized. My developed method allows fast, on-site, and inexpensive preparation of spin-polarized STM tips with the cost below 10 USD (a commercial tip is above 100 USD).

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