Creep and Hysteresis Correction for Atomic-Precision STM Tip Positioning

J. Lake, J. H. G. Owen, E. Fuchs and J. N. Randall

Zyvex Labs, 1301 N Plano Rd., Richardson, TX, 75081, USA

Email: jlake@zyvexlabs.com

Creep and hysteresis errors are a universal issue in all piezo driven Scanning Tunneling Microscopy (STM) operations. These errors affect everything from basic image quality to the ability to perform accurate IV measurements for spectroscopy applications. In this work, we present the results of the development of a real-time correction system for overcoming these persistent tip control issues allowing for atomically precise tip movement and placement.

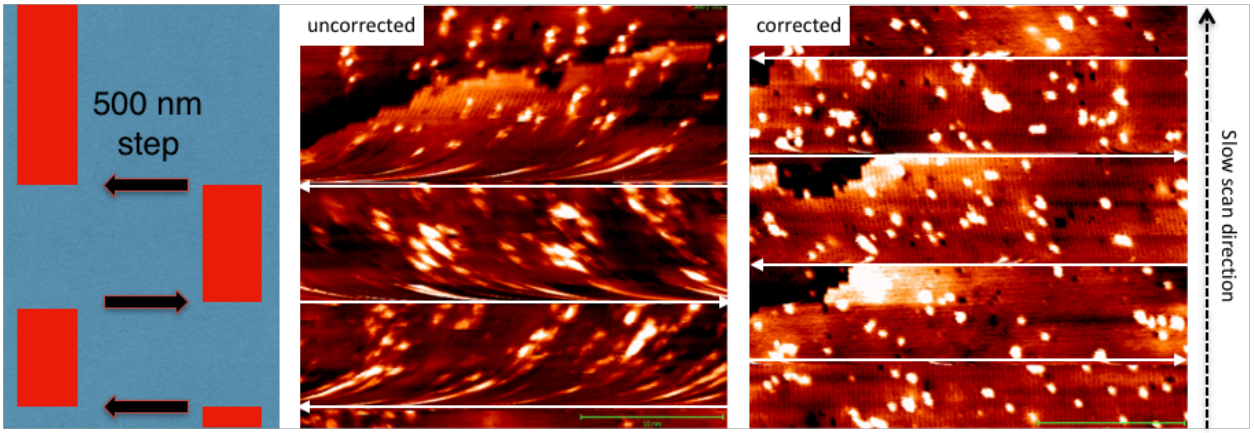

Fig. 1. Sample STM images with uncorrected and corrected creep and hysteresis. In both images the arrows represent 500 nm steps.

Piezo creep results in an undershoot of real position vs. desired position by about 10% of the expected motion. Over time, the tip will drift the last 10%, taking about 10,000s to settle completely. The actual position of the tip at any given moment is therefore path and velocity-dependent. Realtime creep correction is therefore necessary to compensate for each motion as it occurs. Our solution is to apply a voltage overshoot to correct the position undershoot. The applied overshoot voltage is set to decay with time to match the expected creep, keeping the tip at the correct real position. Hysteresis errors are quadratic with the size of the step, and do not decay with time. For a typical piezo tube scanner, hysteresis errors are about 30 nm for a 1 um jump, and around 750 nm for a 5 um jump. A similar process of applying voltage corrections to maintain the desired tip position is used. Observed hysteresis errors can be reduced to single nm for 1um jumps, and to around 10 nm for 5 um jumps. Hysteresis also affects the size of creep errors, so the two must be corrected together

Preference: poster

NOTE:
When saving this file save as: Last name, first initial_PEC2018_Abstract
(e.g., doej_PEC2018_Abstract)