Supplementary Material for

Frequency Spectroscopy of Irreversible Electrochemical Nucleation Kinetics on the nanoscale

Amit Kumar\textsuperscript{1,2}, Chi Chen\textsuperscript{3}, Thomas M. Arruda\textsuperscript{1}, Stephen Jesse\textsuperscript{1}, Francesco Ciucci\textsuperscript{3} and Sergei V. Kalinin\textsuperscript{1,a}

\textsuperscript{1}Oak Ridge National Laboratory, 1 Bethel Valley Road, Oak Ridge, Tennessee 37831, United States

\textsuperscript{2}Centre for Nanostructured Media, Queen’s University Belfast, Belfast BT7 1NN, United Kingdom

\textsuperscript{3}The Hong Kong University of Science and Technology, ClearWater Bay, Kowloon, Hong Kong 00852, People's Republic of China

The circuit diagram and detailed description of the implementation of frequency-voltage spectroscopy are provided here. The circuit diagram for the implementation of the approach discussed in the main manuscript is shown in Figure S1. The frequency control was implemented using a National Instruments (NI) 6115 card which provided the I/O platform for the experiment. A signal generator was used to generate the AC frequency sweep and a relay was used to pass the sweep to the tip until the height change is reached. As soon as the height change criteria was met (typically change in height of 1.5 nm, other values were also used), the relay was turned off and thus the frequency sweep at the location is terminated. The data for height change and frequency sweep was recorded using the NI DAQ card. The tip then moved to the next location where the experiment was repeated until the grid was complete.

\textsuperscript{a} Corresponding author, sergei2@ornl.gov
Fig. S1: Circuit diagram that implements Frequency-bias point by point spectroscopy utilizing height cut-off criteria.