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Controlled Fabrication and High-Resolution Imaging of Molecular-Scale Three-Terminal Devices DOUGLAS R. STRACHAN, DANVERS E. JOHNSTON, BETH S. GUITON, T.-H. PARK, M.J. THERIEN, PETER K. DAVIES, DAWN A. BONNELL, A.T. CHARLIE JOHNSON, University of Pennsylvania — One of the biggest challenges to developing molecular-scale three terminal devices is to precisely fabricate and monitor the formation of the nanometer-scale electrodes (nanogaps). Recently, electromigrated nanogaps have been developed which provide sufficient gate-coupling to produce such devices. We have developed a technique for forming electromigrated nanogaps in a transmission electron microscope (TEM) in order to monitor their formation with high-resolution imaging in real time. The technique relies on computer-controlled electromigration using feedback to produce the nanogaps at room temperature. This TEM imaging allows us to monitor the dynamics of the device evolution, where the gaps remain ordered and clear of residue during the process. Using this technique, we find clear visual evidence for the importance of joule heating in the formation of electromigrated nanogaps. These electrodes can also be directly used in the construction of three terminal nanometer-scale devices. Our results have implications on the development of a wide range of novel molecular-scale devices. This work was supported by the National Science Foundation (NIRT Grant No. 0304531 and MRSEC award DMR05-20020).

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