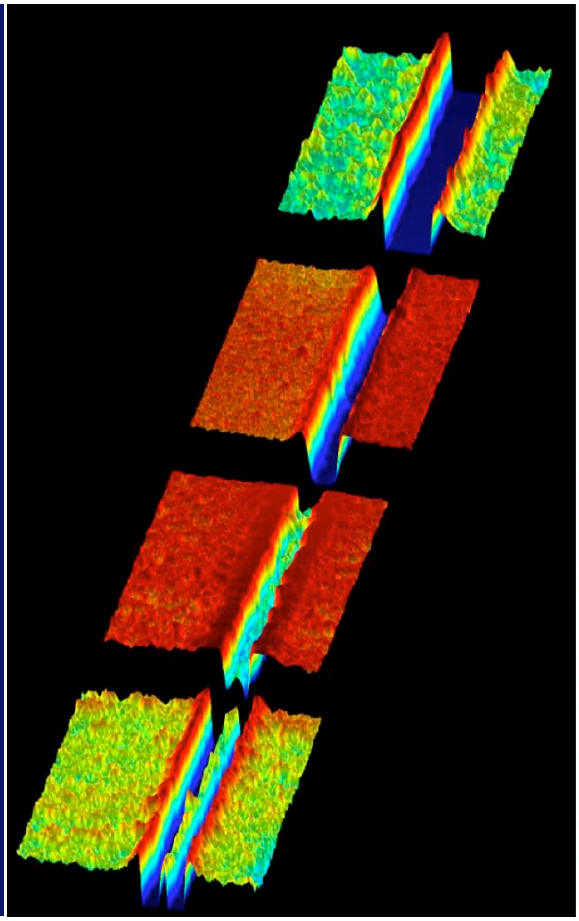
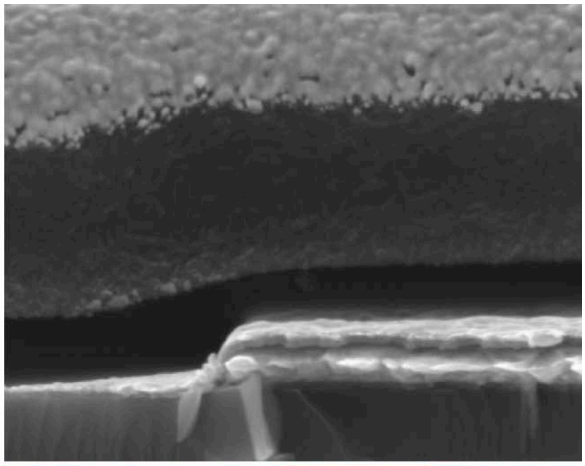
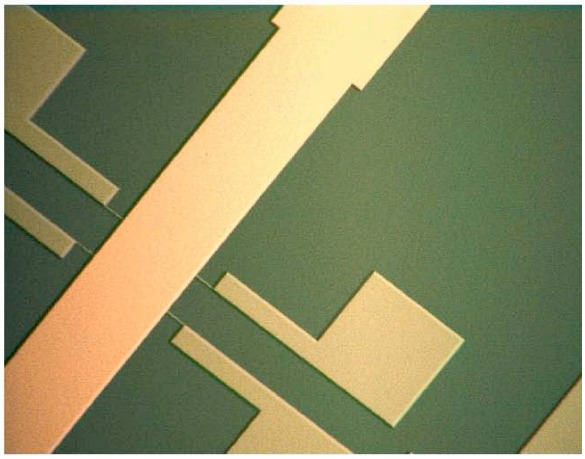
MOLECULAR RULERS

Penn State MRSEC

Left: Metal structures at different steps in the molecular rulers process. Right top: Blending of conventional lithographic resist and ruler resist. Right bottom: Electrodes for the characterization of controllably placed nanogaps.







A marriage of molecule and metal
mind the gap

IRG1

Molecules come in well-defined lengths: Penn State MRSEC researchers have invented a technique called "Molecular Rulers," in which molecular layers of precisely defined widths coat preexisting structures and form templates for patterning new structures with ever-smaller dimensions. Advanced lift-off processing and new bilayer resists, developed in 2005, have dramatically improved the uniformity and sharpness of the nanometer-scale gaps between the parent and daughter structures. These gaps can be tailored with molecular-scale precision.

The Penn State team has developed hybrid nanolithographic strategies that combine molecular rulers and conventional fabrication methods to produce metallic structures with precise proximal placement. The hybrid strategy is compatible with commercial nanolithographic technologies. The gaps so produced allow study of the electrical and optical properties of nanoscale materials and new device structures. Multiplexed test-pad structures enable many parallel, single-gap measurements, with nano-scale structural characterization of selected individual gaps, to optimize the molecular ruler process.

The next goals are to reduce the line-edge roughness of the metal electrodes and to fabricate thin-film transistors and nanowires. By implementing advanced hybrid strategies, molecular rulers become technologically compatible and economically attractive. As lithography presses toward ever-decreasing dimensions, bottom-up methodologies using novel parallel technologies such as molecular rulers can help to circumvent the crippling costs projected for conventional approaches.