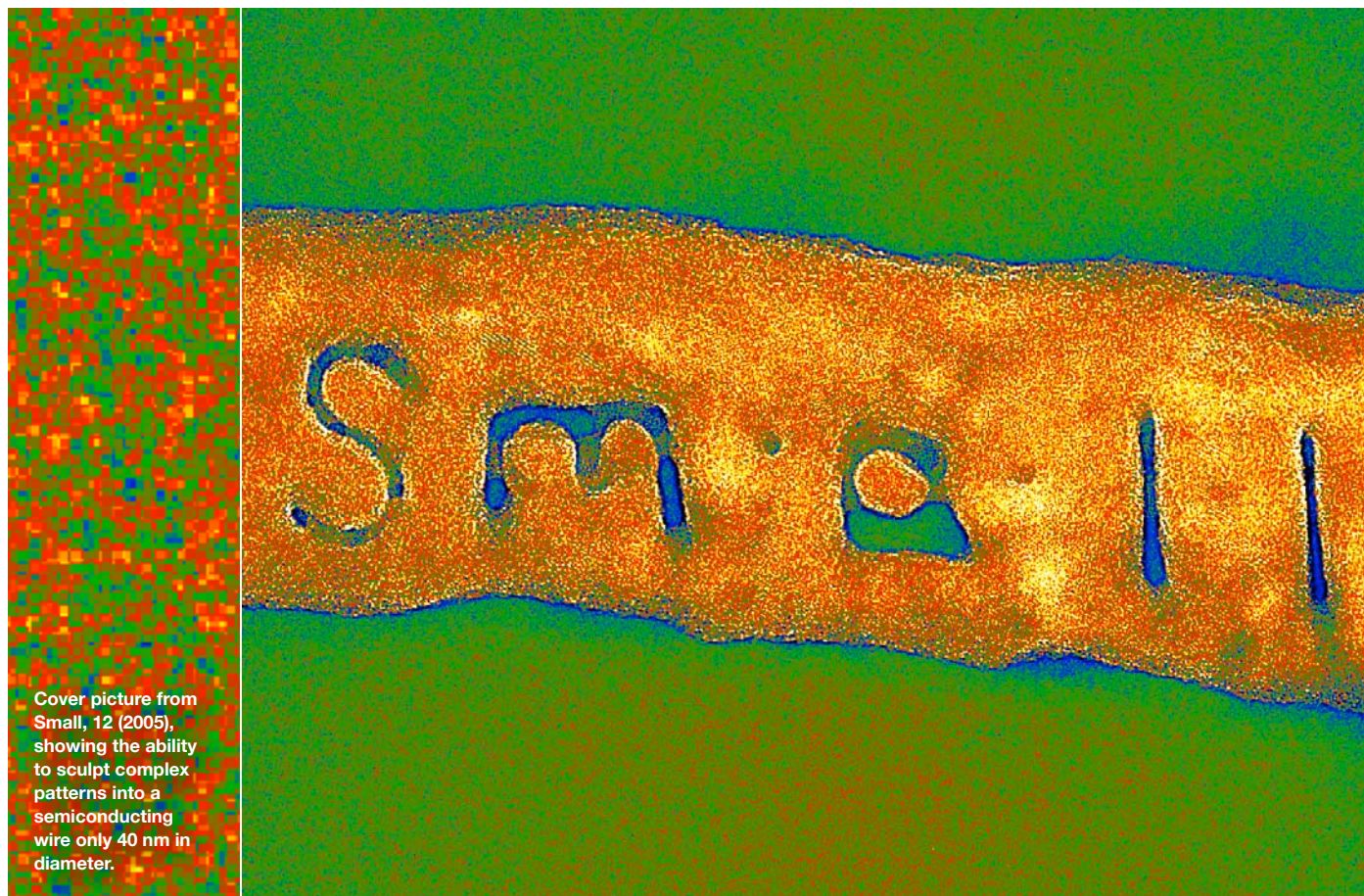


NANOWIRE WELDING

Penn State MRSEC



Cover picture from Small, 12 (2005), showing the ability to sculpt complex patterns into a semiconducting wire only 40 nm in diameter.



High-intensity beams sculpting at the nanoscale

IRG3



Penn State MRSEC researchers Ben Sheng-yong Xu, Mingliang Tian, Jin-guo Wang, Jian Xu, Joan Redwing and Moses Chan have developed a new technique for welding and sculpting materials to create nanometer-scale gaps, holes, bridges, loops, and welds between and within nanowires made from semiconductors and metals. A high-intensity electron beam from a field-emission transmission electron microscope, with a current density of a million amps per square centimeter, can carve holes in nanowires. Lower-intensity beams can weld two nanowires

together to form metal-metal or metal-semiconductor junctions or remove the oxide shell from a nanowire to allow direct access to the crystalline semiconductor underneath. Nano-welding can reduce the contact resistance between a gold nanowire and its leads by ten thousand times.

If the beam size of a field emission scanning electron microscope can be scaled down to one nanometer in diameter, it may be possible to combine high-intensity electron beam sculpting with well-established e-beam lithography for large-scale applications in sculpting and patterning a wide

range of materials at the nanometer scale.