

# Manipulations of Atoms and Molecules by Scanning Probe Microscopy

Ampere A. Tseng<sup>1,\*</sup> and Zhuang Li<sup>2</sup>

<sup>1</sup>Department of Mechanical and Aerospace Engineering, Arizona State University,  
Tempe, Arizona 85287-6106, USA

<sup>2</sup>Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun,  
Jilin 130022, P. R. China

## 3.1. Manipulation of Single Atoms by AFM

Oyabu et al.<sup>40</sup> are believed to be the first group using a cryogenic AFM near a contact mode to study the vertical manipulation of Si atoms on Si(111)-(7 × 7) surfaces. The experiment was conducted at a temperature of 78 K under UHV ( $5 \times 10^{-11}$  Torr). An n-doped Si cantilever with a

Later, Oyabu et al.<sup>41</sup> extended their study to the lateral manipulation of a Ge adatom on Ge(111)-c(2 × 8) surfaces by frequency-modulation AFM. The study observed that the intrinsic adatoms of Ge(111) surfaces are suitable for lateral manipulation by the short-range interaction force acting between the outermost atoms of a tip and the atoms

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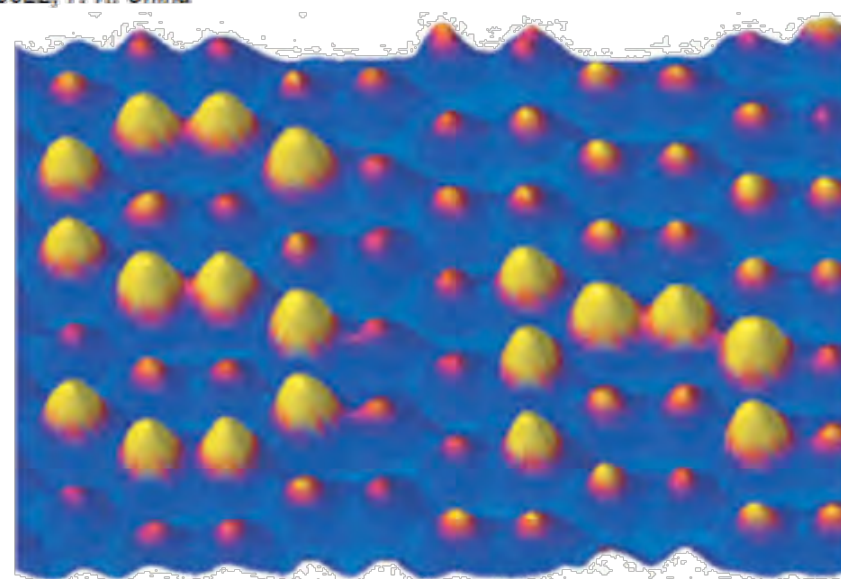


Fig. 9. AFM image ( $7.7 \times 7.7 \text{ nm}^2$  image size) of atom inlaid letter “Sn” by rearranging Sn atoms on Ge(111)-c(2 × 8) surface at room temperature with cantilever oscillation amplitude of 15.7 nm, using Si cantilever of 29.5 N/m spring constant, setting frequency shift value of  $-4.6 \text{ Hz}$  with respect to first-mechanical resonant frequency of 160 kHz (courtesy of Dr. Oscar Custance of Osaka University, Japan).