Prospects for Nanodeposition of Cold Gallium Atoms

O.M. Maragò[1], B. Fazio[1], P.G. Gucciardi[1], F. Fuso[2], C. Vasi[1], and E. Arimondo[2]

[1]*Istituto per i Processi Chimico-Fisici, CNR, sez. Messina,*
Via La Farina 237, 98123, Messina, Italy
Tel +39-090-2939693, Fax +39-090-2939902
E-mail: fazio@me.cnr.it, Website: http://adam1.its.me.cnr.it/ pixy/
[2]*INFM, Dipartimento di Fisica, Univeristà di Pisa,*
Via Buonarroti 2, 56127, Pisa, Italy

The phenomenal rate of increase in the integration of electronics and optoelectronics chips is based on the advance in traditional Optical Lithography. The controlled fabrication of structures at scales smaller than the current limits is a technological goal of great practical and fundamental interest. Material structures with size in the 10 nanometers range represent a bridge between the classical bulk and the quantum mechanical world. In low-size structures the quantum effects play a crucial role in modifying optical and electrical characteristics of materials.
Nanotechnology, because it is concerned with the construction of objects and devices a few nanometer in size, is dependent on the control of matter on the near-atomic scale. The objective of this work is a progress towards the fabrication of nanostructures through laser manipulation of neutral atomic beams, also called Atom Lithography. This technique is based on two steps: first the use of Laser Cooling methods for the high collimation of the atomic beam; secondly the focusing of atoms through a laser beam in standing wave configuration (light mask).
Arrays of lines and dots have been already produced using few different atomic species (for a review see [1]). An important breakthrough for industrial applications, will be the demonstration of Atom Lithography for technologically relevant materials like Gallium [2] or Indium [3] that are among the key building blocks of modern semiconductor devices. The main goal of this work is to demonstrate, for the first time, the Atom Lithography of Gallium atoms. This will open the way for the integration of Atom Lithography with standard deposition methods (e.g. Molecular Beam Epitaxy), with the ultimate goal of industrial-scale fabrication of regularly ordered nanosized structures.

Acknowledgments. This work is supported by 'Consiglio Nazionale delle Ricerche' (CNR) and the IST programme of EU (No. IST-2001-32264).

[1] J. McClelland, *'Nanofabrication via Atom Optics'*, Handbook of Nanostructured Materials and Nanotechnology, published by Academic Press.
[2] Preliminary results on 1D laser cooling of Gallium have been obtained by the group of S.A. Lee at Colorado State University (USA), http://www.physics.colostate.edu/groups/lasers/.
[3] Work is in progress at Uni-Bonn by the group of D. Meschede to demostrate laser cooling and nanodeposition of Indium, personal communication.