

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Neutral Atom Lithography Using the 389 nm Transition in He

By

Jason Reeves

Resist based neutral atom lithography with metastable 2^3S_1 Helium (He^*) has been used to produce small structures in both Gold and Palladium. A beam of He^* from a reverse flow, DC discharge source is collimated by the bichromatic optical force followed by three optical molasses velocity compression stages. The He^* beam then crosses a region where a mechanical or optical mask creates the desired pattern.

In the first experiments, a self assembled monolayer (SAM) of nonanethiol is grown on a Gold coated Silicon wafer and then exposed to the bright, collimated beam of He^* after a Nickel micro mesh mask. The mesh protects parts of the SAM from the 20 eV of internal energy deposited by the impact of a He^* atom onto the sample surface. The pattern of the mesh is transferred into the $\sim 200 \text{ \AA}$ Gold layer with a standard selective etch that removes the Gold from under the damaged SAM molecules. The samples were analyzed with an Atomic Force Microscope and Scanning Electron Microscope.

The second set of experiments were performed using an optical mask to pattern a Gold coated Silicon wafer. In the optical mask, the He^* atoms experience the dipole force while traversing a standing light wave of $\lambda_1 = 1083 \text{ nm}$ light tuned 490 MHz above the $2^3S_1 \rightarrow 3^3P_2$ transition or, in separate experiments, $\lambda_2 = 389 \text{ nm}$ light tuned 80 MHz below the $2^3S_1 \rightarrow 3^3P_2$ transition. Using the optical masks, He^* can be focused or channeled into parallel lines separated by $\lambda/2$ by varying the intensity of the standing light wave.

The small structures created by the 389 nm optical mask began approaching the Gold surface granularity. A $\sim 200 \text{ \AA}$ layer of Palladium on Silicon was chosen as the Palladium granularity is much smaller and the SAM of nonanethiol will still form on the surface. Experiments using a Nickel micro mesh as a mechanical mask have demonstrated similar features to those in Gold.

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