Trapping alkali-atoms with micron wires fabricated on a chip

Michael E. Holmes,a Pedro Quinto-Su,a Michael Wulf,a Nicholas P. Bigelow,a,c Mark J. Feldman,b and Carlos R. Stroud a,c
aDepartment of Physics & Astronomy, University of Rochester, Rochester, New York 14627-0171
bDepartment of Electrical & Computer Engineering, University of Rochester, Rochester, New York 14627-0231
cInstitute of Optics, University of Rochester, Rochester, New York 14627-0186

In the field of cold atom physics, manipulating neutral atoms on micron (5µm) wires is very useful in realizing transportation of quantum bits (qubits) in quantum computing schemes. Before transferring to a microchip, atoms are loaded into a magneto-optical trap (MOT) above a highly reflective silver surface (approx. ~1mm) evaporated on a silicon wafer substrate (900µm). The MOT is created by superimposing the proper laser and magnetic fields sufficient for cooling and trapping of a particular atomic species. We are currently simultaneously trapping $^{133}$Cs and $^{85}$Rb alkali atoms in a mixed two-species surface-MOT. By trapping atoms in this MOT, we are able to cool them to the Doppler limit ($T_D \approx 100 \mu K$) which corresponds to an atom velocity of $v_D \sim 30 cm/s$. By fitting fluorescence data to transient rate equations and spatially imaging the atom sample via CCD camera, fundamental properties of atoms in the trap can be extracted. We consider mechanisms for trap loss inducing cold collisions between atoms in the trap and hot
collisions with background atomic vapor. Studying the interactions due to laser field excitations in a MOT environment has become very important in understanding molecule formation, measuring dipole-dipole interactions in an excited Rydberg state, and molecular behavior in an extremely low temperature (100nK) Bose-Einstein condensate (BEC). Here we will discuss the details of designing and creating wired grids, their role in transporting neutral atoms, and trap limitations. Grids are fabricated onto the reflective surface used to load the MOT. By bringing the atom sample closer to the chip (~25-50µm above the micro-wires) and adiabatically ramping on the micro-fields, ~10^7 atoms can be loaded onto an atom chip with transfer efficiencies up to ~50%.