Applications of a Cold-Atom Lithium Focused Ion Beam

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Focused ion beam sources based on ionization of laser cooled atoms have made significant progress in recent years.[1] Obtaining brightness through ultracold temperatures – several hundred microkelvin or less – rather than small source size, these sources open novel application possibilities by introducing new ion species and enabling low energy focusing at high resolution. Low energy, light ion microscopy,[2] high resolution milling,[3] and implantation[4] have all been demonstrated.

Two application examples of a low energy focused lithium ion beam are imaging of nanophotonic modes in a microdisk resonator and nanoscale implantation of lithium in battery materials to study ion transport. In the former, injected ions create a local perturbation that transiently shifts the resonance, allowing imaging of the optical mode by monitoring optical transmission through the microdisk as the ion beam is scanned. In the latter, local Li implantation in silicon is followed by Kelvin probe force microscopy (KPFM) and scanning transmission electron microscopy electron energy-loss spectroscopy (STEM/EELS) to observe details of the Li distribution.

In this talk I will review progress in cold atom ion source development and present results from the abovementioned examples. Prospects for future source development will also be discussed.

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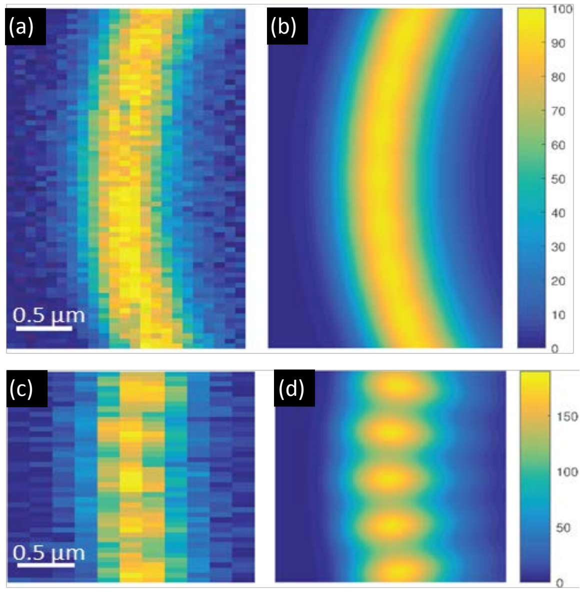

Figure 1: Image of the optical mode distribution in a microdisk resonator. A pulsed focused Li Ion beam is scanned across the field of view while optical transmission is monitored through the microdisk. (a) and (c): mode distributions of a traveling wave and a standing wave, respectively. (b) and (d): Corresponding calculated mode distributions.

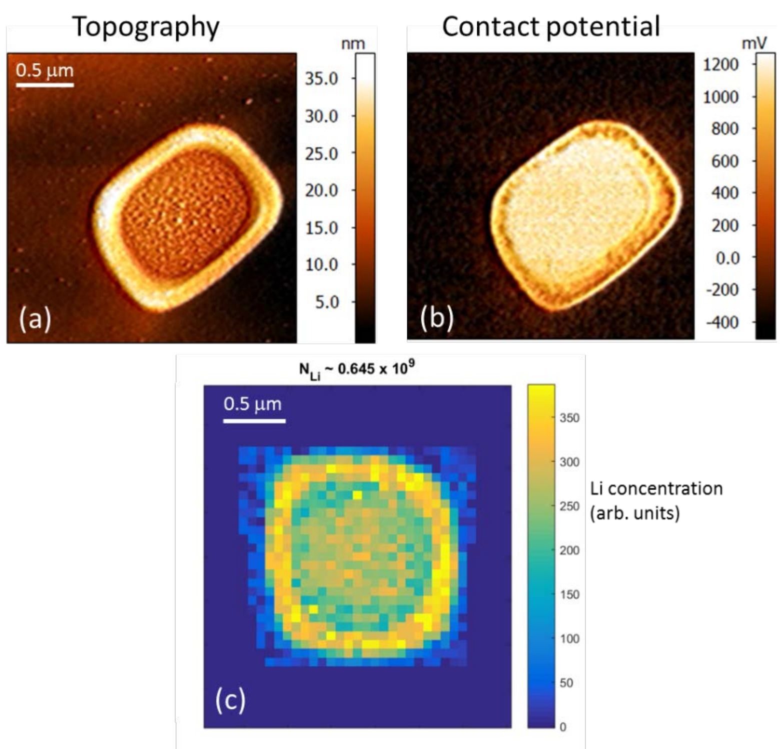

Figure 2: KPFM and EELS map of lithium distribution in silicon. Lithium is implanted in a 1 µm × 1 µm square. (a) Topography and (b) contact potential as measured with KPFM. (c) STEM/EELS map of lithium distribution after implantation in a 35 nm Si membrane.