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Coupling single atoms to micro-ring photonic resonators.[1] BRIAN FIELDS, MAY KIM, TZU-HAN CHANG, CHENG-AN CHEN, CHEN-LUNG HUNG, Purdue University — Trapped atoms on nanophotonics form an exciting new platform for bottom-up synthesis of strongly interacting quantum matters. The ability to induce tunable long-range atom-atom interactions with photons presents a novel opportunity to explore many-body physics and quantum optics. We report our recent effort in migrating cold atoms to a planar photonic platform, which can offer a variety of high-fidelity quantum functionalities due to increased dimensionality and flexibility in photonics design. Our photonic circuit is based on high quality silicon nitride micro-rings (Q=338,000) fabricated on a transparent membrane substrate that is fully compatible with cold atom laser cooling and trapping. We demonstrate that single atoms can be directly loaded into an optical tweezer that is tightly focused on the surface of a micro-ring structure and can be fluorescence imaged. We further show that an optical tweezer can be converted into an optical conveyor belt, transporting trapped atoms into or out of the tweezer focus for full positioning near the planar dielectrics for atom-nanophotonics lattice assembly. We present our progress in coupling these atoms to a high-quality micro-ring with projected large single atom cooperativity ($C \geq 25$). Our experimental platform can be integrated with generic planar photonic waveguides and resonators, promising a pathway towards on-chip many-body quantum optics and new applications in quantum technology.

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