

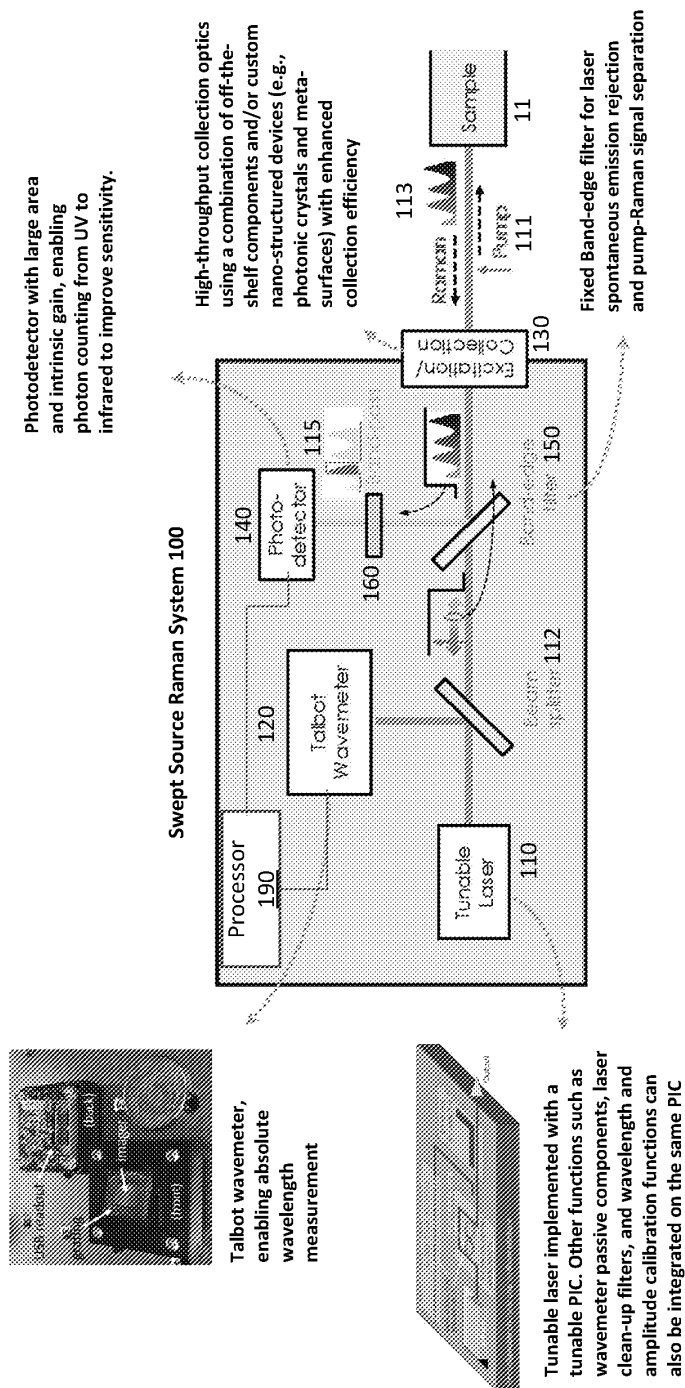
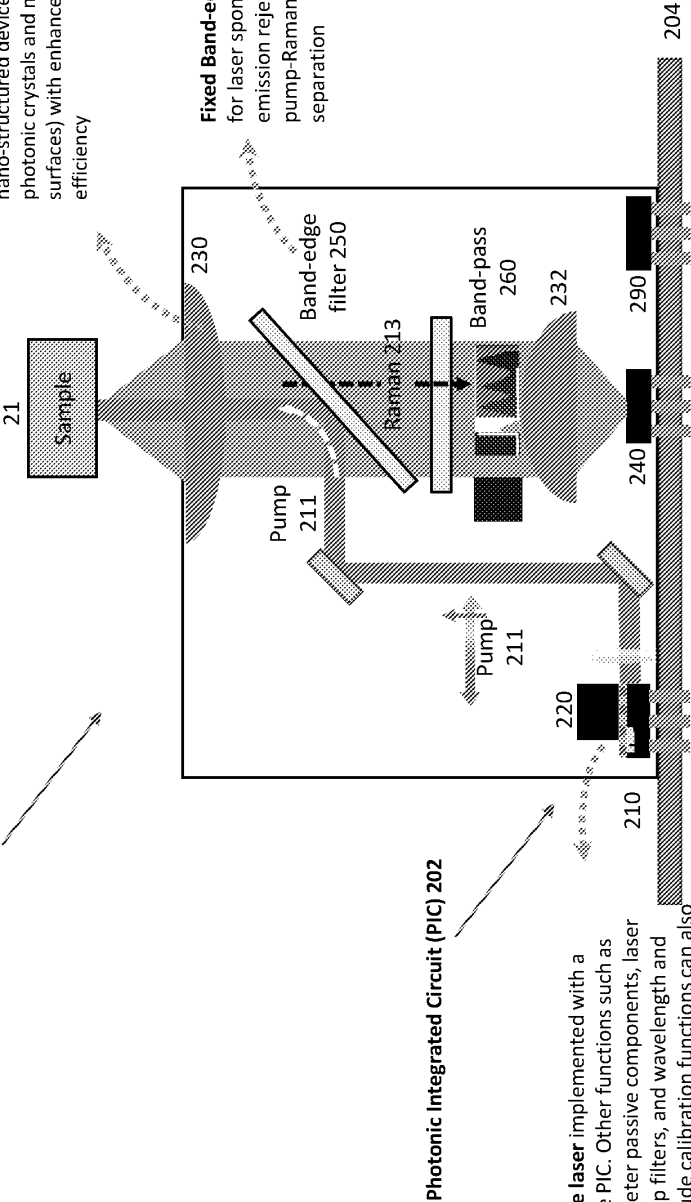


FIG. 1

High-throughput collection optics using a combination of off-the-shelf components and/or custom nano-structured devices (e.g., photonic crystals and metasurfaces) with enhanced collection efficiency

Swept Source Raman System 200



Tunable laser implemented with a tunable PIC. Other functions such as wavemeter passive components, laser clean-up filters, and wavelength and amplitude calibration functions can also be integrated on the same PIC

FIG. 2A

Photonic Integrated Circuit (PIC) 202

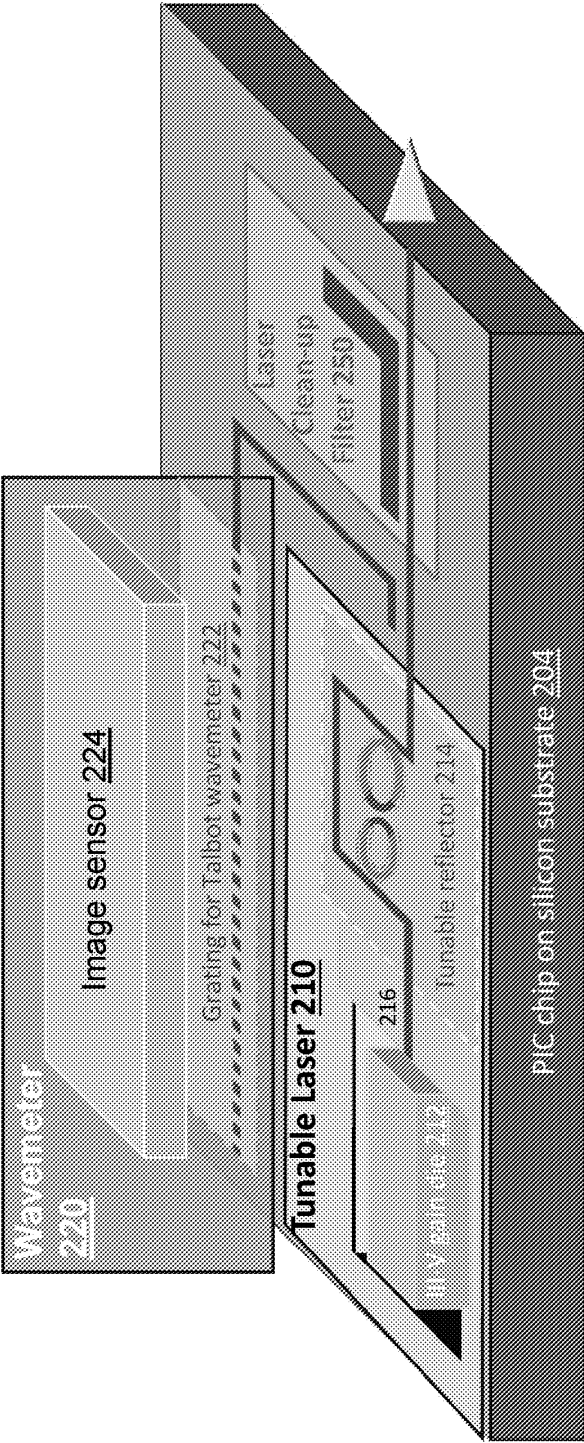


FIG. 2B

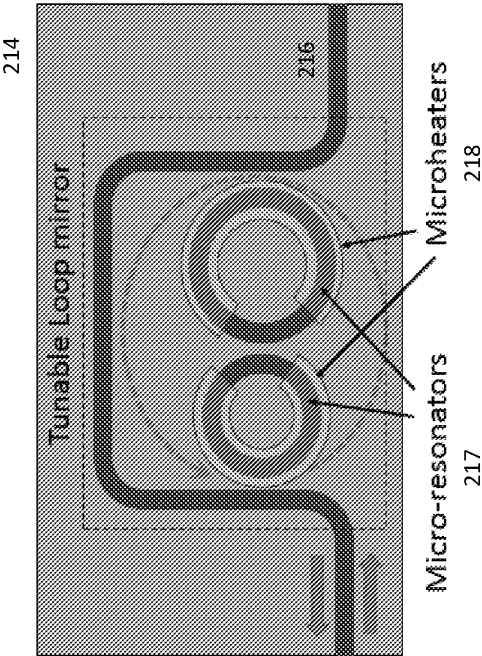


FIG. 2C

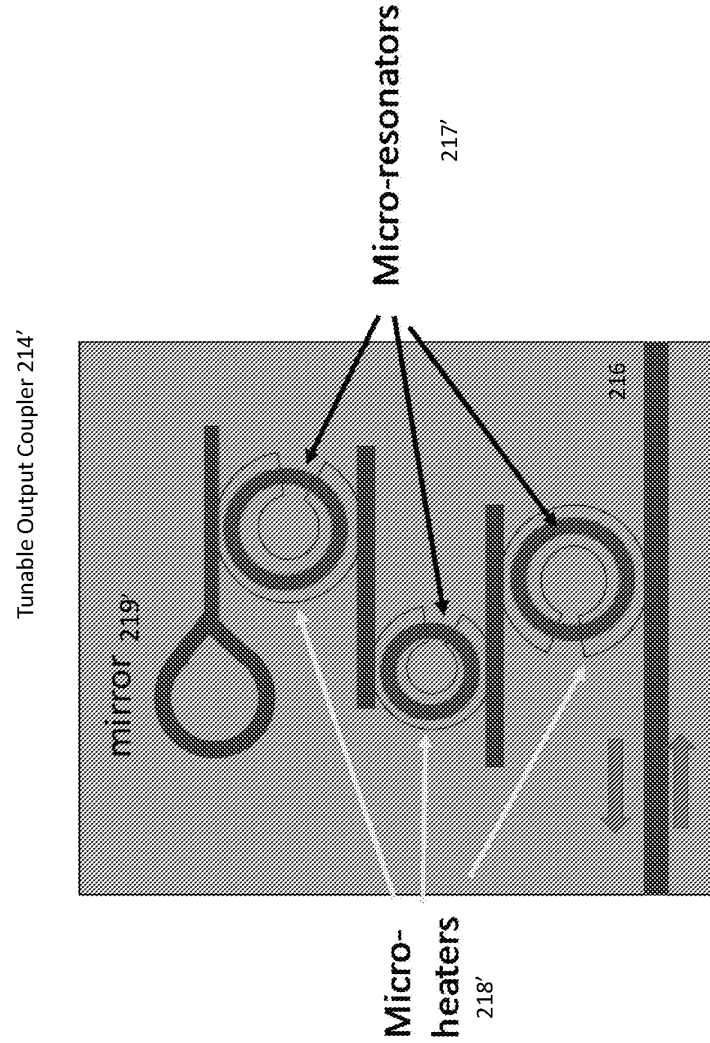


FIG. 2D

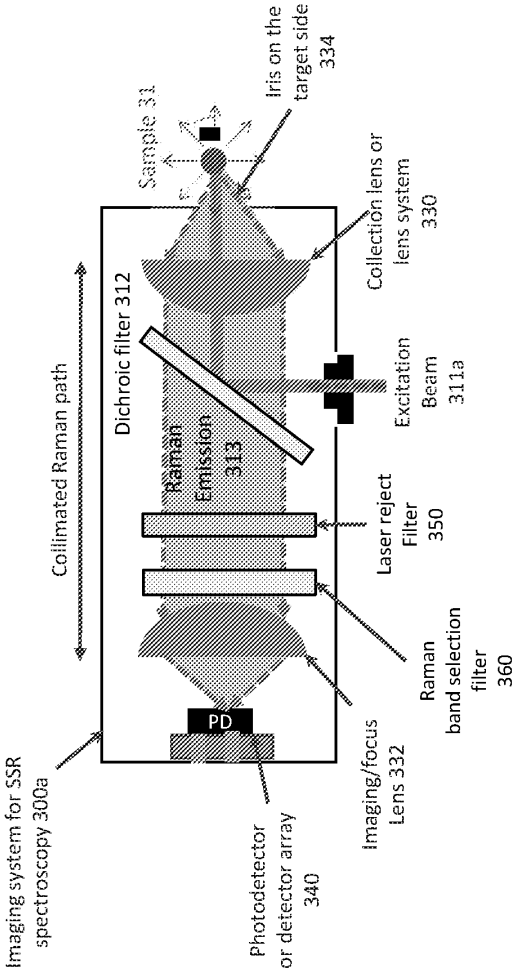


FIG. 3A

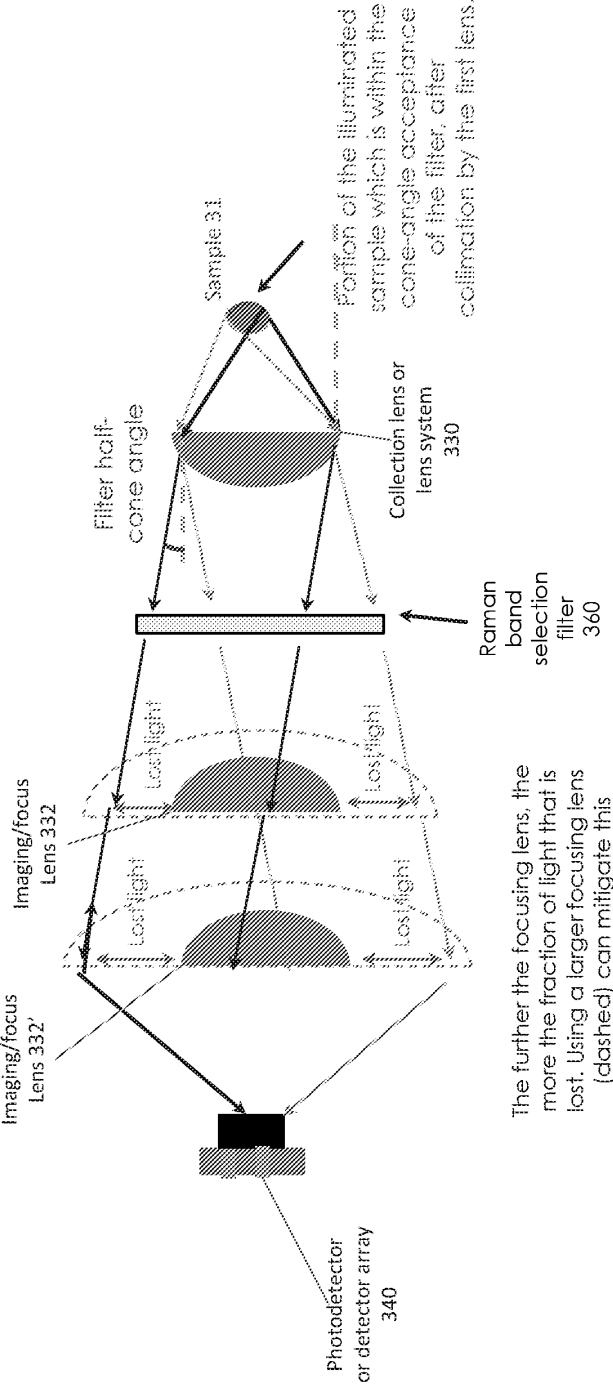


FIG. 3B

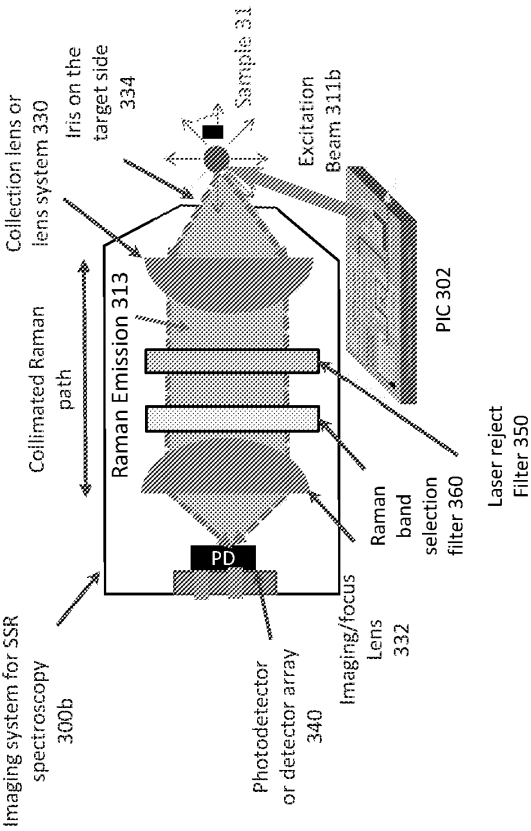
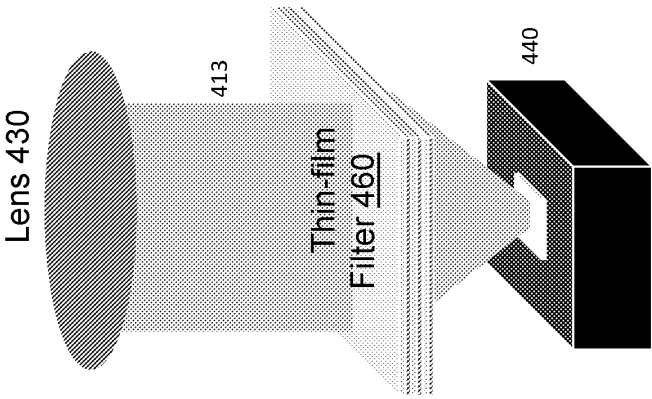
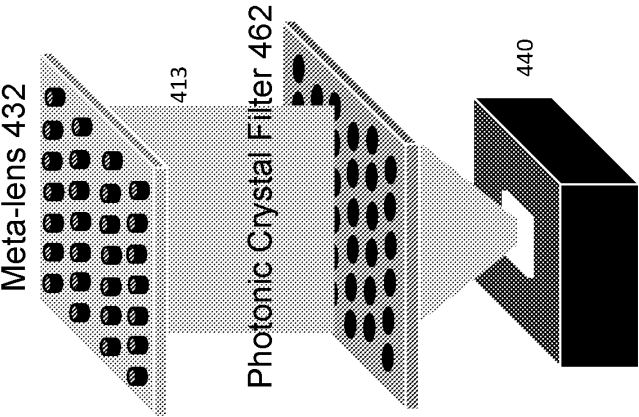


FIG. 3C



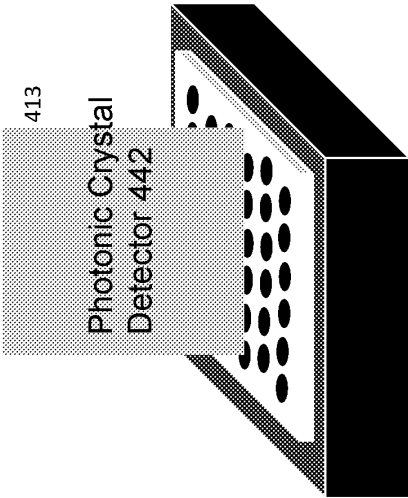
Collection/detection using conventional optics

FIG. 4A



Collection/detection using high-throughput narrowband meta-lens and PhC filter

FIG. 4B



Narrowband PhC surface illuminated detector

FIG. 4C

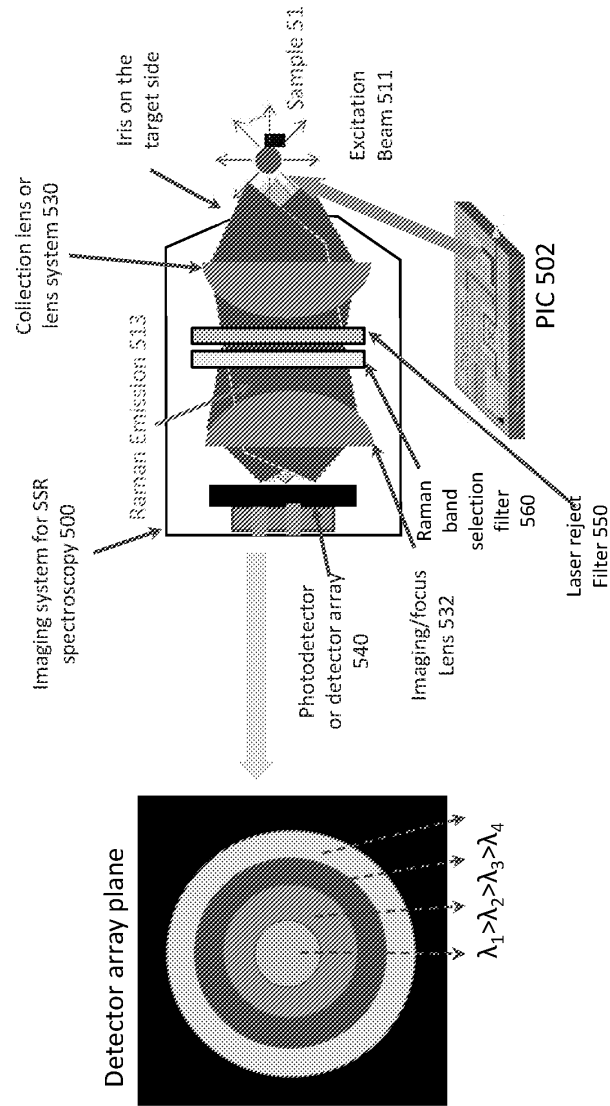


FIG. 5

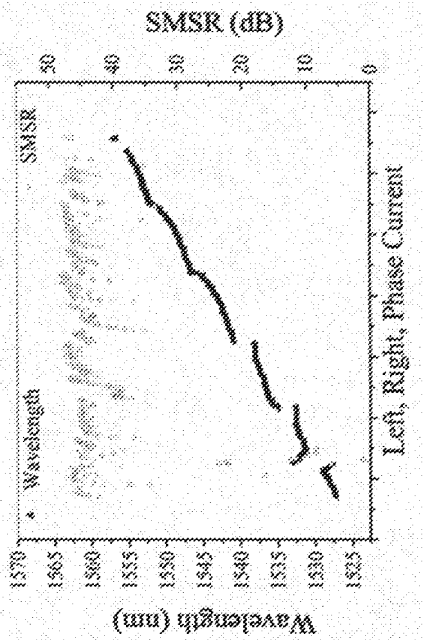


FIG. 6

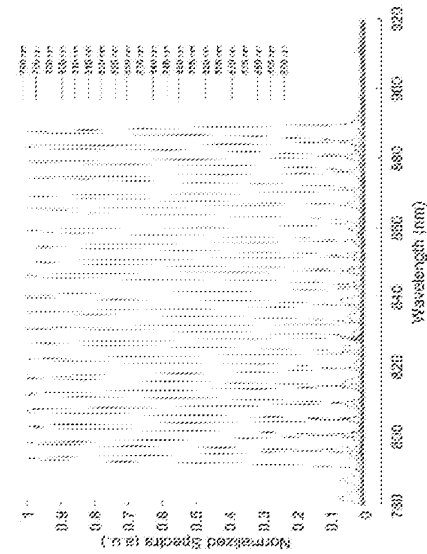


FIG. 7B

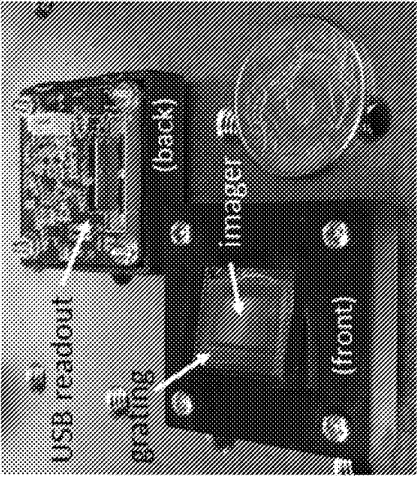


FIG. 7A