Plasmon rainbows for nanoscale sensors and broadband optical circuitry

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Surface plasmons are traveling charge density waves that move along the surface of a metal film. They have unique properties, in that they are easily excited by photons and the plasmon propagation is strongly altered by adsorbates on the metal film. Thus, plasmons are already employed as commercial sensors for biological and environmental applications, and are of considerable interest for light harvesting and energy propagation in nanoscale, planarized optical chip configurations. However, the ability to visualize plasmon propagation up to this point has been technically very difficult, so that evidence for plasmon excitation with light is detected either indirectly by measuring the absorption of photons in the metal, or by the use of nanoscale optical scanning probes.

To address this issue, we developed a unique, scalable excitation and direct detection method for plasmons that uses a high numerical aperture optical objective lens that collects radiative photons from the excited metal, thereby enabling a snapshot to be taken of the propagating plasmon (Figure). Furthermore, the unique excitation scheme simultaneously allows for a smaller excitation spot size and broader bandwidth light source. This enables plasmons to be initiated in a confined region, while also allowing broadband processes used in conventional photonics, such as multiplexing for high bandwidth optical fibers. It also allows a broader range of spectroscopies to be used, enabling additional specificity for identifying molecular adsorbates. Applications for metal films to function in solar cells simultaneously as broadband solar absorbers and electrodes is also envisioned. This work was published in *Optics Letters* **30**, 884 (2005) and *Physical Review B* **71**, 195406 (2005).

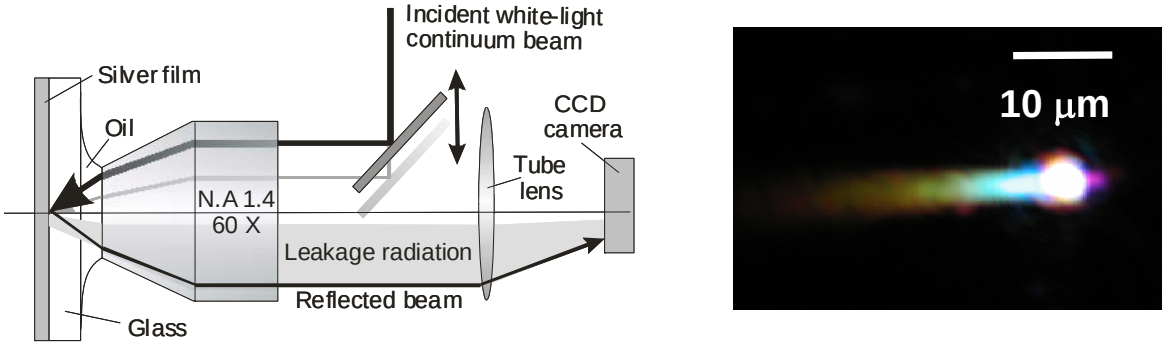

Figure. The experimental apparatus (left) and experimental image of the broadband plasmon rainbow (right) are shown.