Sub-20 nanometer single molecule imaging using mass fabricated pyramidal microstructures

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One primary challenge in near-field optical microscopy is the reproducible fabrication of optical probes that provide both high spatial resolution and strong optical field enhancement. Bottom-up fabrication methods, including the use of a colloidal metallic nanosphere as an antenna, have shown the most promise for reproducible antenna fabrication [1]; however, the sphere geometry is not ideal and therefore does not provide sufficient resolution for many applications and provides only minimal electric field enhancement limiting its application to fluorescence studies. The advantage of high-quality mass-produced pyramidal near-field optical probes is demonstrated.

Recently developed template-stripping microfabrication methodologies are employed to create sharp metallic pyramids [2]. A single pyramid is then used as an optical antenna in a standard aperture-less scanning near-field optical microscope geometry. The pyramid is illuminated from below a transparent sample with a tightly focused radially polarized optical mode, allowing for a strong longitudinal field component at the apex of the pyramid. The pyramid-sample distance is controlled with atomic force feedback and the sample is raster-scanned below the tip. Emitted optical signal is collected by the same objective and sent to an avalanche photodiode or spectrometer.

Using template stripped pyramidal microstructures, we have measured a fluorescence rate enhancement of up to 200-fold with an optical spatial resolution defined by the pyramid tip diameter (15-20nm), shown in Fig. 1.

![Fig. 1](image)

**Fig. 1:** (A) Near-field fluorescence image of single Atto-647N molecules. (B) Cross-section of the molecule denoted by the arrow in A.