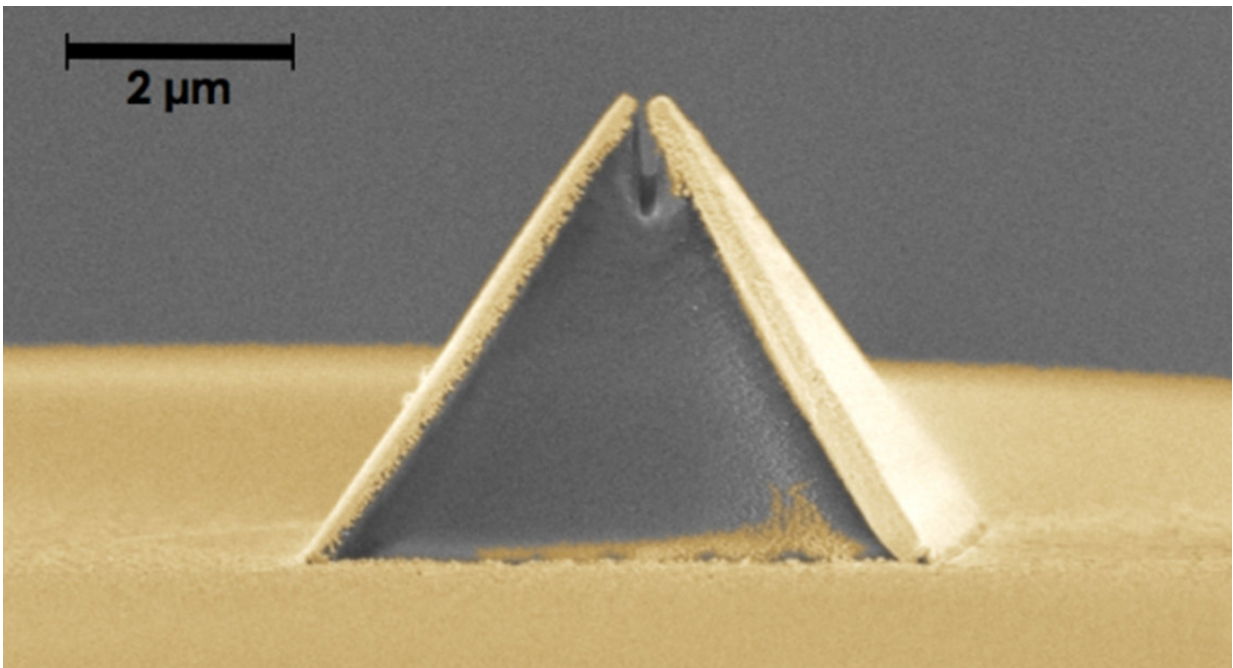


# Imaging probe printed onto tip of optical fiber

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A new process called fiber nanoimprinting is accelerating the fabrication of nano-optical devices, such as this pyramid-shaped Campanile probe imprinted on an optical fiber (captured in a scanning electron microscope image). The gold layer is added after imprinting. The gap at the top is 70 nanometers wide, or 0.000002 inches or 100 times smaller than a single red blood cell. Credit: US Department of Energy

Combining speed with incredible precision, a team of Molecular Foundry scientists and industry users developed a way to print extremely

small devices on the tip of a glass fiber as thin as a human hair. These tiny devices precisely squeeze and manipulate light in ways that are unachievable by conventional optics. The team's approach, called fiber nanoimprinting, builds tips 30 times faster than today's sculpting approach. The scale-up path is to print many tips instead of sculpting individual tips.

Tiny optics could help improve the design of solar cells, pharmaceuticals and semiconductors. Fiber nanoimprinting speeds the production of nano-optics from several per month to several per day. The technique opens the door to mass fabrication of nano-optical devices for widespread use.

Nano-optics have the potential to be used for imaging, sensing, and spectroscopy, and could help scientists improve [solar cells](#), design better drugs, and make faster semiconductors. A big obstacle to the technology's commercial use, however, is its time-consuming production process. The new fabrication method, called fiber nanoimprinting, could unplug this bottleneck. It was developed by scientists at the Molecular Foundry in partnership with users from Hayward, CA-based aBeam Technologies.

Their work builds on the Campanile probe, which was developed by Molecular Foundry scientists four years ago and enables spectroscopic imaging at a resolution 100 times greater than conventional spectroscopy. Fabricating Campanile probes has been part science and part art. The same applies to other nano-optical devices, such as microscopic lenses and beam splitters, which split one light beam into several. These devices require milling a 3-D shape with sub-100-nanometer scale features on the tip of a wispy fiber, which is much trickier than fabricating a nanostructure on a flat surface such as a wafer.

That's where fiber nanoimprinting come in. Its first step is the most time

consuming: scientists create a mold with the precise dimensions of the nano-optical device they want to print. For the Campanile probe, this means a mold of the probe's nanoscale features, including the four sides and the light-emitting 70-nanometer-wide gap at the pyramid's top. After the mold is created, it is filled with a special resin and then positioned atop an optical fiber. Infrared light is sent through the fiber, which enables the scientists to measure the exact alignment of the mold in relation to the fiber. If everything checks out, ultraviolet light is sent through the fiber, which hardens the resin. A final metallization step coats the sides of the probe with gold layers. The result is a quickly printed—not meticulously sculpted—Campanile probe. By doing this over and over, the team can make a [probe](#) every few minutes.

**More information:** Giuseppe Calafiore et al. Campanile Near-Field Probes Fabricated by Nanoimprint Lithography on the Facet of an Optical Fiber, *Scientific Reports* (2017). [DOI: 10.1038/s41598-017-01871-5](https://doi.org/10.1038/s41598-017-01871-5)

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