INTER(ior) View

BY REBECCA LINDELL

The laser labyrinth

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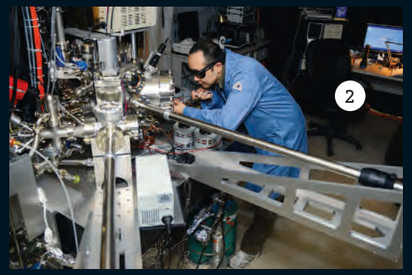
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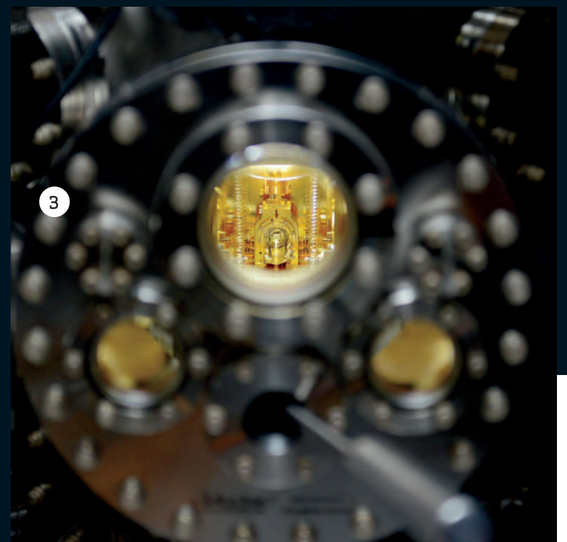
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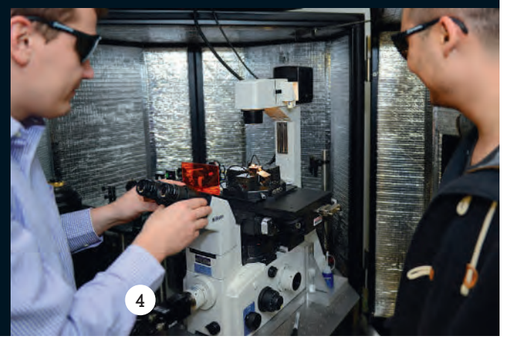
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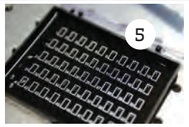
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“All of science is reductionist,” says Professor **Richard Van Duyne**. “You try to create the simplest possible system to understand something in great depth.” If that is so, then Van Duyne’s work with lasers may be the most reductionist of all.

The lasers and equipment in Van Duyne’s lab illuminate how the most infinitesimal bits of matter behave at the tiniest increments of speed. “When you’re looking at a molecule with dozens of atoms all moving every which way, it looks very complicated,” Van Duyne says. “But when you reduce it to the motion of a single atom, it becomes beautiful in its simplicity.”

1 Ytterbium fiber laser

Researchers in the Van Duyne lab use lasers with different characteristics, depending on the materials they are studying and the questions they seek to answer. Some experiments require that the beams be pulsed at different rates—up to 1 million times per second—or that they hit the material in a particular sequence. Using these beams, scientists study molecules and reactions with a technique called “surface-enhanced Raman spectroscopy,” which Van Duyne discovered in 1977.

2 The lab’s “crown jewel”

The only machine of its kind in the world, this intricate device was unveiled in 2010 after seven years of construction. Consisting of 10,000 individually engineered parts, it combines a scanning tunneling microscope (an instrument that allows researchers to study individual atoms on surfaces) with an ultra-high vacuum chamber.

3 Ultra-high vacuum chamber

Inside the ultra-high vacuum chamber are conditions that mimic outer space, devoid even of gases such as oxygen or nitrogen. By guiding lasers into this extremely low-pressure zone, researchers can examine with unique accuracy the properties of single molecules on surfaces.

4 Vibrational isolation chamber

The silver walls of this compartment shut to create a vibration-proof interior. Within the chamber, lasers and an atomic-force microscope are used to study the composition of various materials. The stability is important, Van Duyne notes, because given the tiny scale of the particles being analyzed, any movement at all—even vibrations from traffic on Sheridan Road—can send measurements askew.

5 Tip-enhanced Raman spectroscopy

This box contains dozens of sharp metal tips that are only a few nanometers wide at the end. Researchers use these tips to sample materials, creating topographic “maps” that reveal the composition and spatial arrangement of the molecules.

6 19th-century letter

By placing one of the tips on this piece of paper and applying the tools of laser spectroscopy, researchers can determine the precise age of this 19th-century letter. They can even determine where it was likely written, because different ink manufacturers used different “recipes” for their ink. The technique has enabled researchers to date artwork and detect forgeries for institutions such as the Art Institute of Chicago, which has collaborated with Van Duyne’s lab for years. ■

PHOTOS: ROB HART