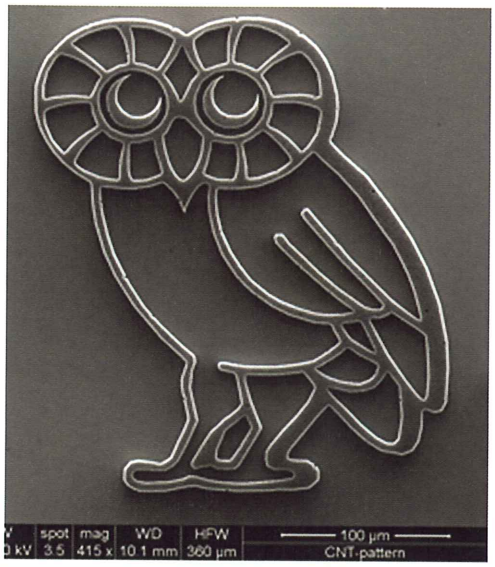

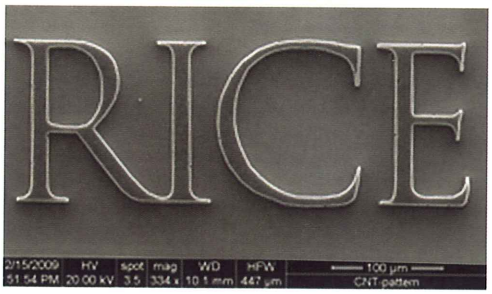

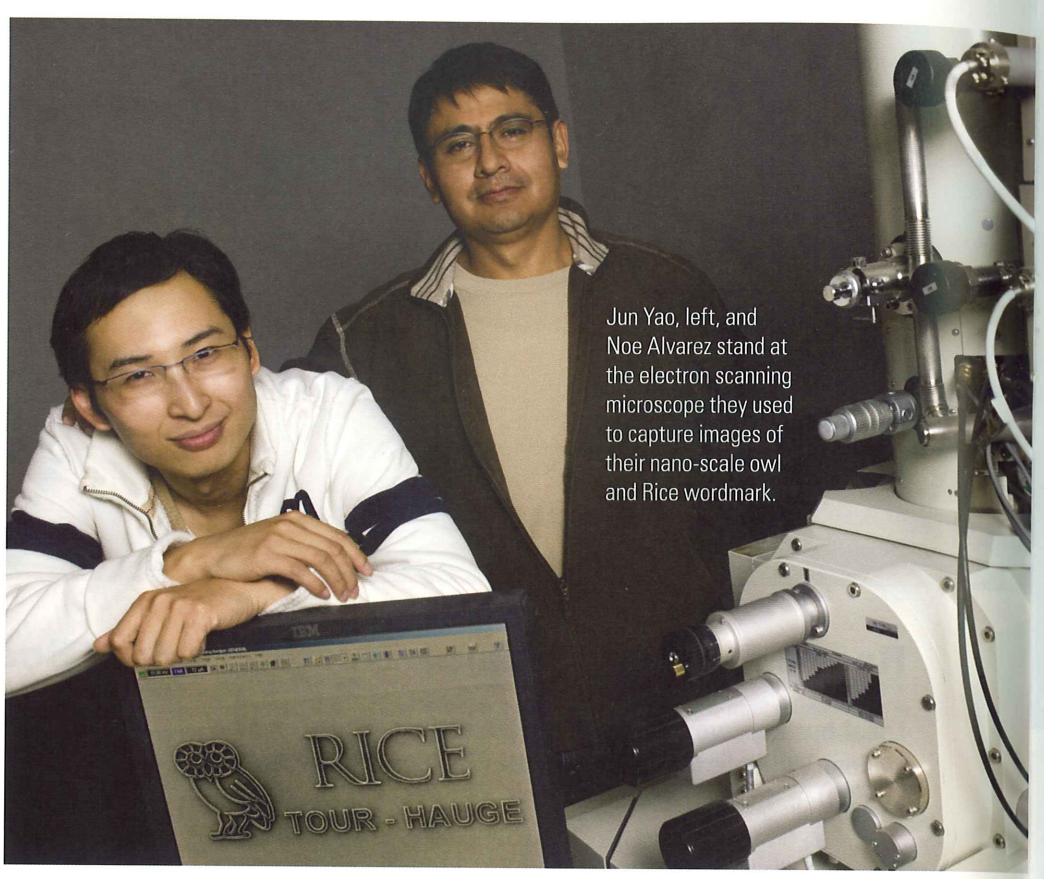

Jun Yao, left, and Noe Alvarez stand at the electron scanning microscope they used to capture images of their nano-scale owl and Rice wordmark.

Tiny Owls Take Flight

You might want to fly this Rice Owl and wordmark at Rice's next baseball game, but since each is only about twice the width of a human hair, you'd need a very tiny pennant. The images are made of carbon nanotubes grown in carpets by means of a process developed at Rice. (See article on Page 4.)

Jun Yao, a graduate student in the labs of James Tour, Doug Natelson and Lin Zhong, drew the Rice Owl and wordmark at the behest of his friend and colleague Noe Alvarez, who recently earned his doctorate at Rice. He used a mouse to painstakingly trace the images into a computer program that controls the electron beam of an electron scanning microscope. "I really wanted to use the Rice logo made of nanotubes on one of my slides for the Ph.D. defense committee," Alvarez recalled. "We finished the drawing in time, but the electron scanning microscope we needed to create the image at the nano-scale was broken."

Alvarez said that he and Yao made the nano-owls for fun, but they still wanted to get a good look at their creations. When Alvarez later noticed that the microscope had been repaired and was sitting idle, he grabbed the opportunity to make a few portraits of the tiniest owl ever. The images consist of more than 10 million nanotubes — each of which is about 1/50,000th the diameter of a hair — and appear to the naked eye as barely visible dots.

Yao explained that the process of creating the images involved layering a silicon wafer with a 10-nanometer-thick alumina substrate and a slim coating of liquid poly(methyl methacrylate), aka PMMA. "We bake it at 180 degrees centigrade for two minutes to crystallize the liquid," he said. "We already had the image in the computer, so we just had to program the electron beam to trace the pattern into the PMMA."

They used a developer to wash away the PMMA that had been exposed to the electron beam, followed by deposition of a .5-nanometer iron catalyst film and then an acetone bath to remove the catalyst outside the nano-owl pattern. "Then we put it in the reactor, where the carpet grows in about 15 minutes," Alvarez said.

Alvarez, who worked in the labs of co-advisers Tour and Robert Hague, a pioneer in the growth of nanotube bundles, will leave Rice soon for a postdoctoral position at Japan's National Institute of Advanced Industrial Science and Technology. ■

—Mike Williams

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