

nano-American flag/nano-White House

The *nano*-American flag and the *nano*-White House were created by scientists and engineers at Cornell University to celebrate the 21st Century Nanotechnology Research and Development Act¹.

What is nanotechnology? Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 - 100 nanometer range². A **nanometer** is one-billionth of a meter.

The nano-American Flag

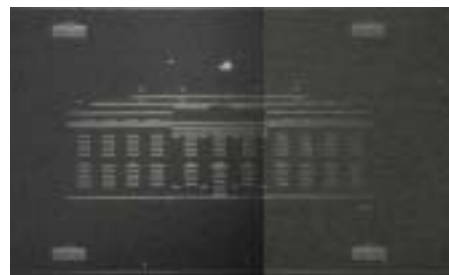
The *nano*-American flag was created using **nanotechnology**. It is 3 millimeters (about one-tenth of an inch) wide by 1.5 millimeters tall. The tools and processes used to create the *nano*-American flag are similar to those used to create computer chips and other nanoscale devices. The *colors* in the American flag are produced by a distinct pattern of lines etched into a thin layer of glass coating a silicon wafer. These tiny lines spaced at nanometer dimensions diffract specific wavelengths of light producing the *red, white* and *blue* colors. **Diffraction gratings, such as the ones used here, have applications in telecommunications, biomedicine and analytical chemistry.**



Objects at the nanoscale are devoid of color since their dimensions are smaller than the wavelength of light. In this American flag, the stars (really squares) are 75 micrometers across, about one-half the width of a human hair. Each star is made of 36 separate lines spaced to reflect, blue, green and red light. Combine these colors and we see the white stars. Each stripe on the flag is made up of 52 separate lines. The difference in spacing for the blue and green lines is 72 nanometers and from green to red is 45 nanometers.

The nano-White House

The *nano*-White House was produced using state-of-the art silicon processing technology that is housed in the Cornell NanoScale Science and Technology Facility which is supported by the National Science Foundation. There is one 'large' White House that is 4.5 millimeters across and four smaller White Houses, each at 510 micrometers across, flank the larger White House. Atop each *nano*-White House is an American flag that measures 19x10 micrometers. The smallest feature are the stars for the above flag and lines that make up the smaller White Houses which are approximately 500 nanometers wide. To put this into perspective, four *nano*-White House stars or lines would fit across the width of a red blood cell. Inside of today's computer chips the *wires* are now routinely thinner than the thinnest column in the *nano*-White House. In fact you could line-up five computer *wires* across the width of the White House column.



The *nano*-American flag and the *nano*-White House represent the science and technology efforts of the Nanobiotechnology Center, the Cornell Center for Materials Research, the Center for NanoScale Systems and the Cornell Nanoscale Science and Technology Facility, all supported by the National Science Foundation. The *nano*-American flag and the *nano*-White House were created by Scott Stelick and Madanagopal Kunnnavakkam in the Batt Research Group at Cornell University.

¹ <http://www.WhiteHouse.gov/news/releases/2003/12/20031203-7.html>

² <http://www.nano.gov/html/facts/whatIsNano.html>

