A Simpler Design for X-Ray Detectors

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A simplified design for ultra-sensitive X-ray detectors offering more precise materials analysis has been demonstrated at the National Institute of Standards and Technology (NIST). The advance is a step toward making such devices cheaper and easier to produce. Users may eventually include the semiconductor industry, which needs better X-ray detectors **to identify and distinguish between nanoscale contaminant particles on silicon wafers.**

The new design, described in the Sept. 13 issue of Applied Physics Letters,* is among the latest advances in a decade of NIST research on superconducting "transition edge" sensors (TES). These cryogenic sensors absorb individual X-rays and then measure the energy of the X-ray by measuring the resulting rise in temperature. The temperature is measured with a bilayer of normal metal and superconducting metal that changes from zero resistance (superconducting) to a slight resistance level in response to the heat from the radiation. By measuring the X-ray energy, NIST researchers can identify the X-ray "fingerprints" of particular elements.

NIST researchers have built systems offering 30 times better X-ray energy resolution than detectors now used in the semiconductor industry and are pursuing further improvements such as novel detector geometries and materials. In contrast to the usual bilayer TES design, the sensor described in the APL paper combines the normal and superconducting metals into one homogenous layer. Manganese impurities are added to a 400-nanometer-thick aluminum film to lower its superconducting transition temperature to 100 milliKelvin.

Fabrication requires about half as many steps as the bilayer design. In addition, the new design exhibits less "noise" in the X-ray signals than is typical for TES sensors, as well as a low sensitivity to magnetic fields that could help in building stable instruments.

Scientists at the University of Notre Dame and Santa Clara University also participated in the research. The work was supported in part by NASA.

Source: NIST