Argonne NATIONAL LABORATORY

Center for Nanoscale Materials

Award-winning grids and collimators produce better X-ray and nuclear images

A grid as little as three millimeters tall could save lives by helping X-rays and radiotracers provide clearer diagnostic images of the human body.

These X-ray anti-scatter grids and nuclear collimators, developed by scientists at the U.S. Department of Energy's Argonne National Laboratory and Creatv MicroTech, Inc., won an R&D 100 Award from R&D Magazine, identifying it as one of the top scientific and technological innovations in the world introduced as a product during 2005. They also were on the Micro/Nano 25 – Technologies of Tomorrow list, selected by the editors of Micro/Nano Newsletter and R&D Magazine as one of 25 micro- and nanotechnologies likely to have the largest impact on their specific industries and society in the years to come.

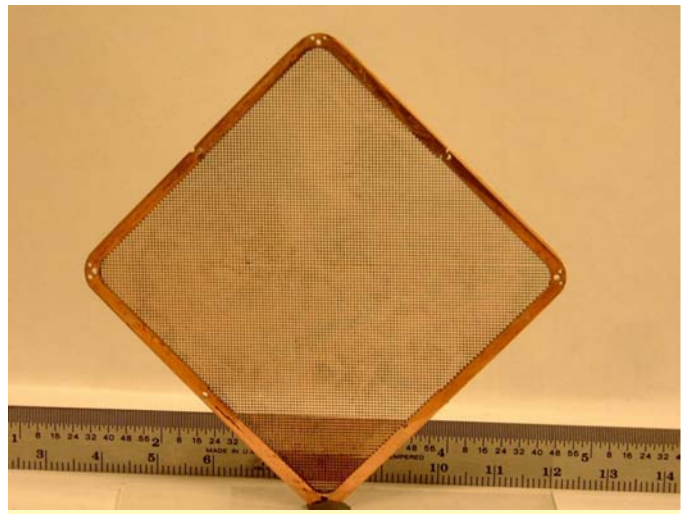
"The two areas where it's important for medical imaging are mammography and gamma ray imaging," developer Derrick Mancini of Argonne's Center for Nanoscale Materials said. "Both of them are critically important for early detection of cancer and other diseases. The impact, therefore, is saving lives."

X-rays produce the images used in medicine as a result of their ability to travel through matter, creating an image based on the density of the matter. However, when a beam of X-rays hits the target, the X-rays are attenuated and scattered. Scattered X-rays modify and cloud the image, which can lead to medical misdiagnoses.

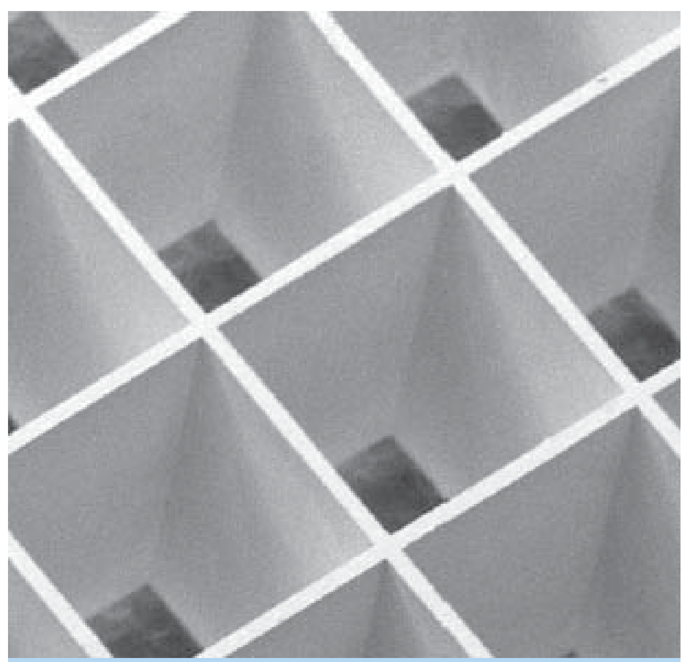
Anti-scatter grids are placed between the target and the imager to reduce this X-ray scattering.

"The basic concept of an anti-scatter grid is not new," said Cha-Mei Tang, president of Creatv MicroTech, "but our method can make two-dimensional grids that reduce scatter to less than one percent. This is far more effective than one-dimensional grids currently on the market, which reduce scattering to about 10 percent."

The anti-scatter grids developed by Argonne and Creatv MicroTech, however, are superior to existing anti-scatter grids because they are made using a method called



BETTER X-RAY IMAGING – Anti-scatter grids can improve X-ray imaging for mammography, chest X-rays and other medical applications.



COPPER GRID – Scanning electron microscope image of a 2.8-mm-thick copper grid.

LIGA, a German acronym that refers to lithography, electroforming and molding.

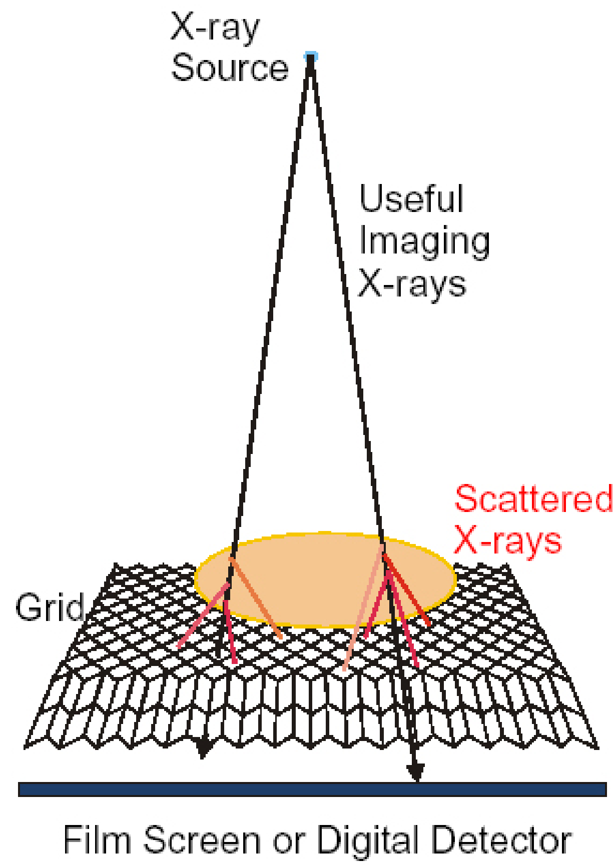
Argonne's Advanced Photon Source (APS), which provides the most powerful X-ray beams in the Western Hemisphere, is normally used to analyze materials. The LIGA anti-scattering grid is the first time that the APS was used in the fabrication of an industrial product. To make an anti-scatter X-ray grid in the LIGA method, X-rays from the APS burn a deep grid pattern into a thick polymer. After placing the exposed polymer in a developer, the polymer mold for the grid pattern is obtained. The grid mold is filled with metal by electroplating, and when the polymer is removed, a grid results.

While many previous anti-scatter grids were one-dimensional, the LIGA grids consist of two-dimensional cells. These cells are divided by walls as thin as 25 microns (millionths of a meter), a thinness that cannot be achieved with other methods for making anti-scatter grids, such as casting, foil folding and chemical etching. For one-dimensional grids, the measured transmission of primary X-rays is 72 percent. A competing cellular grid transmits 80 percent, but the LIGA grid transmits the highest proportion of primary X-rays: 87 percent.

Nuclear medicine is similar to X-ray imaging in that it looks at what goes on inside the body, but different in that radiotracers are used. Nuclear images focus on the function and chemistry of body parts the radiotracers encounter, rather than on the structure of body parts. Gamma cameras pick up the gamma-rays emitted by the radiotracers, and nuclear collimators placed in front of the gamma cameras select the appropriate gamma-rays. Nuclear collimators also benefit from the use of LIGA-produced grids.

Developers of the grids and collimators were Derrick Mancini, Ralu Divan and Judi Yaeger at Argonne; Olga Makarova, Guohua Yang and Cha-Mei Tang at Creatv MicroTech, Inc.; former Argonne employee Nicolaie Moldovan, now at Advanced Diamond Technologies, Inc.; and former Argonne and Creatv MicroTech employee Vladislav N. Zyryanov, now at Illinois Institute of Technology.

Argonne and Creatv MicroTech started working collaboratively on this project nearly eight years ago, when both organizations discovered they were working on similar technology. They handled different aspects of the project, Creatv MicroTech focusing on design, manufacture, fabrication and testing for medical applications and Argonne focusing on fabrication methods.



ANTI-SCATTER – Schematic of an anti-scatter grid. Human tissue atenuates and scatters X-rays. The two-dimensional grid absorbs scattered X-rays, but allows the primary X-rays to reach the imager.

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