Seeing X-rays in a new light: Soft X-ray detector could improve breast cancer imaging

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Krishna Mandal examines a recently fabricated soft X-ray detector.

(Phys.org) -- A slice of light is about to come into focus for the first time, thanks to a new X-ray detector constructed at the University of South Carolina. And according to Krishna Mandal, the associate professor of electrical engineering who led the team that built it, the detector offers tremendous potential in breast cancer detection and treatment.

“There’s nothing available on the market that covers this range of X-rays ,” Mandal said. “Nobody has explored this region, and there will be many innovations that will result from our being able to do so, particularly when it comes to medical imaging.”

X-rays are part of the electromagnetic spectrum, which ranges from lowenergy radio waves to high-energy gamma rays. X-rays are on the high-energy end of the spectrum, just below gamma rays – they're more energetic than ultraviolet light, which is more energetic than visible light.

As they just reported in *Applied Physics Letters*, the USC engineers have developed a laboratory-scale device that sensitively detects what are called "soft X-rays" – those on the lowest end of the X-ray energy scale.

At the other end of the X-ray spectrum are hard X-rays. The typical "X-ray" taken at a doctor's or dentist's office is a black-and-white photograph showing where hard X-rays were able to penetrate (the black area) or unable to penetrate (the white area) the object between the X-ray source and detector.

"If you take mammography as an example, hard X-rays pose difficulties," Mandal said. "First, they have very high energy, and so we have to minimize exposure to them." Soft X-ray devices are potentially less harmful to patients than those based on hard X-rays, he said.

"And more importantly, the soft X-rays interact with calcifications in the tissue," he added. "Hard X-rays do not – they just pass through calcium deposits."

Calcification is the deposition of calcium minerals in body tissue; in the breast it can be an indicator of pathology. Not as opaque as bone to X-rays, calcium deposits represent an very promising target for detailed soft X-ray mapping, Mandal said. He envisions the new soft X-ray detectors being at the forefront of a new way of imaging breast tissue, so that physicians can follow progression of calcification over time.

"It's common for women even under 40 years of age to have calcifications," Mandal said. "It's critical to know whether it exists in the tissue and especially whether it is spreading."

"But to see that, we need very high resolution detection systems, which is what we've made. These detectors are instantaneous, real-time and will be able to operate at room temperature with high resolution."

Mandal's team constructed the detector through epitaxial growth of silicon carbide on wafers of 4H-SiC. They were tested for response to soft X-rays at both the Los Alamos National Laboratory and Brookhaven National Laboratory.

The resulting detectors exhibited high sensitivity for soft X-rays (50 to 10,000 electron volts). There are no commercially available soft X-ray detectors covering this range, Mandal said, and comparison with an off-the-shelf ultraviolet detector showed a much more robust response for soft X-rays with the new device.

Provided by University of South Carolina

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