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# New technology sharpens X-ray vision

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Dark-field image of chicken wing. Credit: Franz Pfeiffer, EPFL/PSI

Researchers at the Paul Scherrer Institute (PSI) and the EPFL in Switzerland have developed a novel method for producing dark-field x-ray images at wavelengths used in typical medical and industrial imaging equipment.

Dark-field images provide more detail than ordinary x-ray radiographs and could be used to diagnose the onset of osteoporosis, breast cancer or Alzheimer's disease, to identify explosives in hand luggage, or to pinpoint hairline cracks or corrosion in functional structures.

Up until this point, dark-field x-ray imaging required sophisticated optics and could only be produced at facilities like the PSI's 300m-diameter, $200 million synchrotron. With the new nanostructured gratings described in this research, published online January 20 in *Nature Materials*, dark-field images could soon be produced using ordinary x-ray equipment already in place in hospitals and airports around the world.

Unlike traditional x-ray images, which show a simple absorption contrast, dark-field images capture the scattering of the radiation within the material itself, exposing subtle inner changes in bone, soft tissue, or alloys. The overall clarity of the images is striking. The improved sensitivity in measuring bone density and hairline fractures could help diagnose the onset of osteoporosis. Because cancer or plaque cells scatter radiation slightly differently than normal cells, dark-field x-ray images can also be used to explore soft tissue, providing safer early diagnosis of breast cancer or the plaques associated with Alzheimer's disease.

Security screening equipment equipped with dark-field image capability could better identify explosives, whose micro-crystalline structures strongly scatter x-ray radiation. And because x-rays penetrate a material without damaging it, dark-field images could help reveal scattering-producing micro-cracks and corrosion in structures such as airplane wings or the hulls of boats.

"Researchers have been working on dark-field x-ray images for many years," explains Franz Pfeiffer, a professor at EPFL and researcher at the PSI. "Up until now these images have only been possible using sophisticated crystal optical elements." Crystal optics, however, only work for a single x-ray wavelength and thus are highly inefficient. "Our new technique uses novel x-ray optical components, in the form of nanostructured gratings, that permit the use of a broad energy spectrum, including the standard range of energies in traditional x-ray equipment

used in hospitals or airports," adds Christian David, Pfeiffer's colleague at PSI. "This opens up the possibility for adapting current imaging equipment to include dark-field imaging."

Pfeiffer plans to collaborate with the Center for Biomedical Imaging (CIBM), a joint center with the Universities of Lausanne and Geneva and their associated hospitals, to develop an adaptation for existing medical equipment. "When combined with the phase contrast imaging technique that we developed in 2006, we now have the possibility of providing the same range of imaging techniques in broad-spectrum x-ray imaging that we do with visible light."

Source: Ecole Polytechnique Fédérale de Lausanne