1.4.6. X-RAY BACKSCATTER IMAGING WITH A NOVEL TWISTED SLIT COLLIMATOR

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Within the most common radiological applications, scattered radiation remains a nuisance since it decreases the object contrast and may even blur sharp contours. Particularly above the energy of 200 keV, Compton scattering becomes increasingly the predominant mechanism of X-Ray absorption also for materials with higher atomic number. In order to make a virtue out of necessity, several approaches have been realised to utilise the scattered radiation in order to gain information about the interrogated specimen. In difference to the X-Ray diffraction which occurs at much lower energies, the Compton scattering is distributed over all directions of space. It has something in common with illuminating a specimen with light, with the difference that the radiation penetrates the specimen while attenuated. The fact that dense materials such as heavy metals absorb any radiation, incident or scattered, can be seen as the reason that light materials show a particularly efficient backscattering effect. Low Z-materials dominate in giving contrast to a backscatter image. Two major problems have to be resolved when intending to image an object illuminated with X-Rays: 1. the lacking optics for radiation in this range of energy and 2. The shielding requirements for beam guiding and shielding of ubiquitous radiation not related to imaging the object. To achieving at least a contrast better than 100 times requires several centimetres of heavy metal.

Generally, two ways are possible to achieve an X-Ray backscatter image: the scanning approach and generating an image “at a glance” with a device similar to a pinhole camera. The first one has been realised already commercially in security applications. Herein, the object is scanned with a pencil beam and all the backscattered radiation is measured by large area high sensitive detectors. The planar coordinates are given by the direction of the pencil beam and the intensity of the corresponding pixel results from the detector reading. When considering a camera system, the whole specimen to be interrogated is illuminated by the X-Rays. However, the optics problem needs to be resolved. Alternative to several approaches such as cone shaped pinholes, Soller collimators or coded aperture diaphragms; a novel collimator has been developed which consists of a twisted slit in a heavy metal block that can be several centimetres thick. The special shape allows pinhole characteristics in several directions in spite of the layer thickness of the diaphragm. This twisted slit collimator has been successfully used to generate backscatter images from various objects, from bottles with liquids to certain features underneath the surface. The advantage of this approach is the freedom to shape the incident beam in order to highlight certain components within a specimen which is not possible so far with the scanning technology. The novel twisted slit collimator offers certain application possibilities in NDT and in security inspections.