

DESK-TOP X-RAY MICROTOMOGRAPHY: INSTRUMENTATION AND APPLICATIONS

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Nowadays many different microscopic methods and equipment, each with varying possibilities and limitations, are at the disposal of the scientist. For non-destructive 3D visualization the choice is limited. Most existing microscopes can visualize the surface or a thin section of an object. Sectioning however means that the internal structure can only be investigated destructively. Even with the most delicate preparation or cutting methods specimen structure could change dramatically. X-ray computer tomography (CT) is a technique which allows to reconstruct the 3D internal structure of objects non-destructively without any prior preparation. This method can show the full internal three-dimensional structure inside opaque objects without cutting, coating or vacuum treatments.

The CT technique is not new. It was developed in the seventies as a medical imaging system. In X-ray tomography radiographic projections are taken from different viewing angles from 0 to 180 degrees. Each of the recordings is fed into a computer. From these projections the 3D structure of the object can be calculated using a reconstruction algorithm.

Typically the spatial resolution for medical CT-scanners is limited around 1mm. In many fields of research where one is interested in evaluating objects in 3 dimensions including the internal structure, this resolution is too low. Using synchrotron radiation sources one is able to reduce the resolution in the sub-micron range. But this kind of sources is only available at limited sites in the world and one has only limited access to do experiments.

Recently, with the arrival of a new generation of commercially available compact microfocus X-ray sources, slow scan CCD cameras and powerful microcomputers it has become possible to construct desktop X-ray microtomographs with a resolution of the order of micrometers, that can fit in any laboratory environment. A limitation of the technique is that the maximal size of the object is restricted because for each radiographic projection the object has to stay in the field of view.

Applications for X-ray microtomography can be found in many areas of research and development: semiconductor industry, petroleum industry, composite materials, plastic and metallic foams, archeology, geology, biology (e.g. seeds, bone structure), defects in diamonds and many more.

We expect that further progress in X-ray sources and cameras combined with new reconstruction algorithms will allow improvements in spatial resolution and permit the use of larger specimen.