Desktop X-ray microtomography for studies of metal foams

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Abstract

Recent improvements in microfocusing X-rays and developments in camera design allowed for the construction of a highly versatile and cost-effective desktop microtomography system.
This instrument offers interesting possibilities for non-destructive studies of 3D structures of metal foams and porous materials.
X-rays tomography has been used for more than a decade for investigation of metals. Resolution has been improved over the years, and the present state of the art allows for resolutions up to 8 micrometer. Due to their X-ray absorption properties, metal foams are a primary target for investigations with this new generation of CT-scanners. The technique is unique in allowing detailed investigation of metal foams prior to deformation or destruction.

1. Principles of X-ray microtomography

A conical beam of X-rays with energy from 10 up to 80 keV is generated from a very small focal target. After traversing the sample, the beam is recorded by an X-ray sensitive CCD camera. Due to the conical shape an enlarged radiograph can be recorded. In microtomography the object is rotated so as to obtain a large number of radiographic projections from different orientations. The processing of these projections using a backprojection algorithm allows reconstruction of a 3D image of the sample [1,2].
The highest resolution is generally limited by the focus of the x-ray tube. The use of a microtarget is essential in this respect.

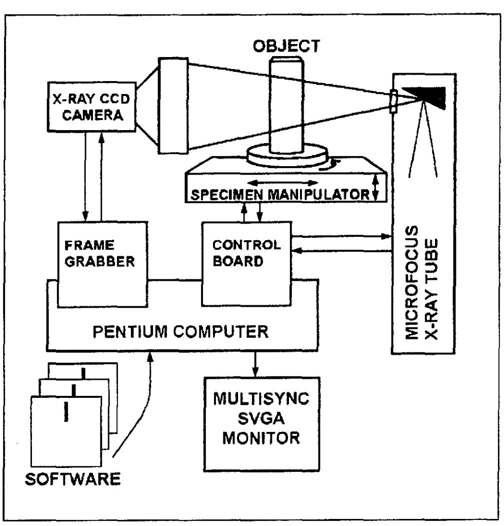

Fig.1. Setup of Microtomograph

2. Equipment

The desktop X-ray microtomograph used for the present images contains a microfocus tube, precision specimen manipulator and a X-ray CCD camera. An Intel Pentium computer processor is used for instrumental control and tomographical reconstruction.

J. Banhart, M.F. Ashby, N.A. Fleck: *Metal Foams and Porous Metal Structures.* © MIT Verlag (1999)

This instrument has been developed in the Visionlab-group of the University of Antwerp and has been improved and commercialised by the spin-off company Skyscan.
Recordings where made using an 80 kV tube with 8 micron source size and a 2D CCD detector with 1024x1024 pixels and pixelsize 12 micron. The scintillator is coupled with a 2:1 reduction fibre optics such that the total field of view is 25 millimeter. The final resolution (voxel size) depends on the diameter of the object, as for the reconstruction the whole object must be within the limits of the beam. For an object less than 10 millimeter the resolution is limited by the x-ray source and of the order of 10 micrometer. For an object of 120 mm or more the resolution will be limited by the detector and would be of the order of 30 micrometer. The image format for shadow projections and reconstructed cross-section consist of 1024x1024 pixels. All recordings of the necessary radiographs for 3D-reconstruction can be made within half an hour.

3. Results

Figure 2 shows microscans from aluminium alloy-foam.
The "Leichtmetall-Kompetenzzentrum Ranshofen" prepared the sample from Al-powder mixed with TiH_2 (0,1 wt%), extruded and heated in a mold for foaming. From a sheet of 0.8 cm thickness slices of about 0.8x0.8x2.5 cm^3 were cut. For the recording 80 keV x-rays where used.

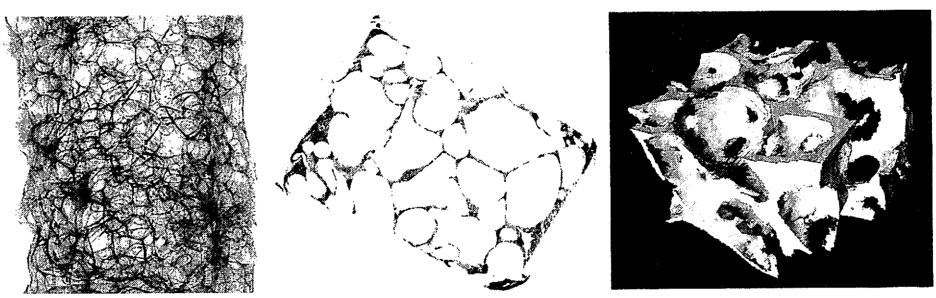

Fig 2. From 104x1024 radiograph, over 2D- to 3D reconstruction of Al foam

4. Conclusions

Although the use of microtomography is not new for the study of metal structures, these samples show that this new generation of desktop X-ray CT-equipment with its increased resolution and compact construction could contribute favorably in the study of metalic foams.

References

[1] A. Sasov, Journal of Microscopy, 147, p. 169-192 (1987)
[2] A. Sasov & D. Van Dyck, Journal of Microsopy, 191, pp 151-158 (1997)