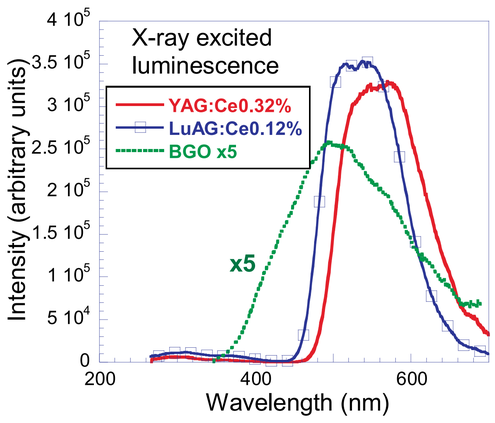
Single Crystal Scintillator Plates Used in X-Rays Micro-CT Applications

J. Tous, P. Horodysky, K. Blazek / *Crytur Ltd., Turnov, Czech Republic*
M. Nikl, J.A. Mares / *Academy of Sciences of the Czech Republic, Institute of Physics, Prague, Czech Republic*

Recently, very thin scintillator imaging plates became of great interest. In high resolution X-rays microradiography, very thin scintillator layers of about 5-20 micrometers are used to achieve spatial resolution around one micrometer. Such thin screens are mainly used in micro-CT and nano-CT systems with either micro-focus X-ray tubes or with synchrotron sources.

Single Crystal Scintillation Materials and Imaging Screens



YAG:Ce ($Y_3Al_5O_{12}$) Yttrium Aluminum Garnet
LuAG:Ce ($Lu_3Al_5O_{12}$) Lutetium Aluminum Garnet

Czochralski Grown Single Crystals

Screen Thickness Down to Several Micrometers

Yttrium aluminum garnet activated by cerium is a fast scintillator with excellent mechanical and chemical resistance. YAG:Ce scintillation detectors are the preferred choice for electron microscopy, beta and X-ray counting, as well as for electron and X-ray imaging screens.

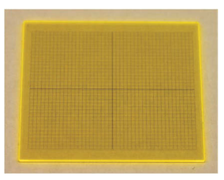
Lutetium aluminum garnet activated by cerium or europium is a scintillator with a high absorption to X-ray radiation and excellent mechanical and chemical resistance. LuAG:Ce scintillation detectors are the preferred choice for X-ray radiography imaging screens.


High-Quality YAG:Ce Single Crystal


5 μm Thin YAG:Ce Screen


Thin YAG:Ce Screen on FOP


Thin YAG:Ce Screen on Alumina Frame


LuAG:Ce Screen with a Grid

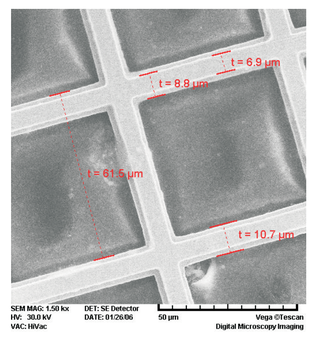
High Spatial Resolution Imaging System


High-Resolution X-Rays Imaging Digital Camera

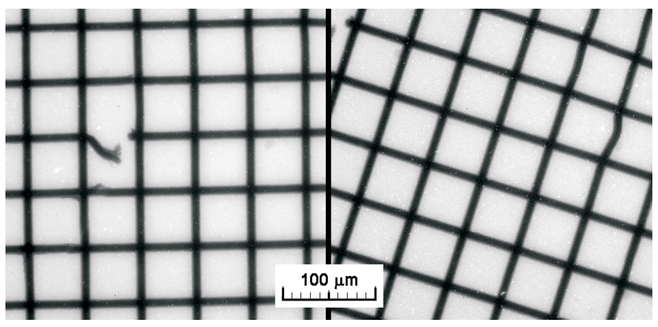
The X-ray CCD camera was tested either with several small biological objects (insect or small animals) or with special grids. The 2D-spatial resolution achieved in the images was about 1 micrometer.

The images were taken using a microfocus X-ray tube with Cu anode@ 40kV/2mA

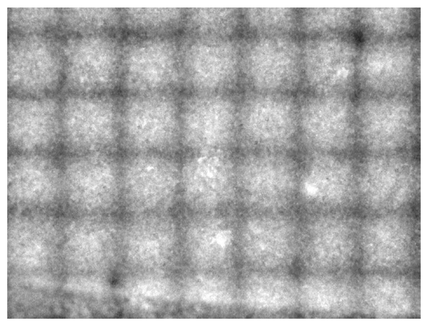
High resolution imaging system is a combination of a high sensitive digital CCD camera and an optical system with a thin scintillator imaging screen.
Very thin (down to 5 microns) screens of YAG:Ce were developed for imaging applications requiring high spatial resolution. The 2D-spatial resolution of an X-ray or other ionizing radiation imaging systems is one of the critical parameters in non-destructive micro-radiography and radiation beam inspection.

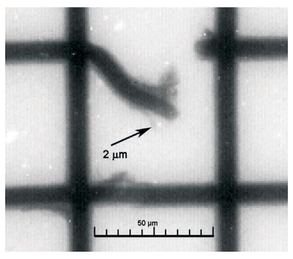


SEM Image of the Test Grid



Radiographies of the 8-Microns Grid Imaged by LuAG:Ce (left) and YAG:Ce (right) Thin Plates


The Grid Imaged by P43 Powder Scintillator



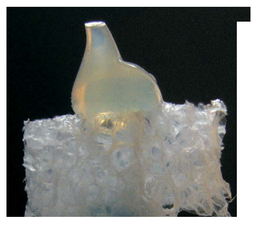
Detail of the Broken Wire

The high resolution of the system with YAG:Ce thin screen is compared to a standard P43 phosphor screen using the same conditions. The objects is a gold grid with the wires 8 microns wide. The images were taken by using the 20 micrometers thick YAG:Ce imaging screen or 20 microns thick phosphor P43 (GADOX), both on quartz glass.

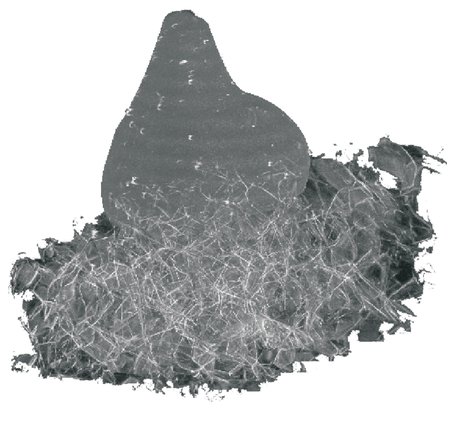
High Resolution X-Rays Radiography of Light Weight Materials

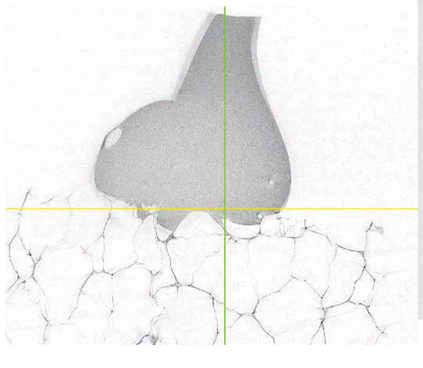
The Grid with 8 Microns Wires

Plastic Foam with Glue Drop

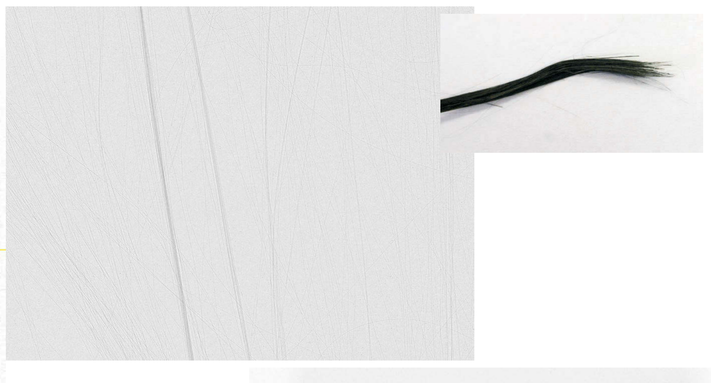


3-D Reconstruction





X-Rays Radiography of Carbon Fibres



X-Rays Radiography of a Spider

The images were taken using a X-RayWorX micro-focus X-ray tube with Cu transmission target. The CCD camera used 0.050 or 0.01 mm thick YAG:Ce plates. Exposition of one projection took several seconds. The CCD sensor has the size of 4050x2630 pixels. Pixel size is 9 microns. The reconstruction was done using Octopus 8.5 software.

X-Rays Radiography of Carbon Ski Stick

The support of Czech GA AV project KAN300100802 is gratefully acknowledged.