TOMOGRAPHY WITH MIXED NEUTRON AND GAMMA BEAMS

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Summary: It is presented a non destructive testing of an electrolytic capacitor at INUS imaging facility from Institute for Nuclear Research (INR) using a mixed beam of thermal neutrons and gamma radiations delivered on a tangential channel by a TRIGA Annular Core Pulsing Reactor (ACPR). 2D projections of the capacitor on a scintillator are captured with an EM-CCD type camera followed with processing by 3D reconstruction, segmentation and animation.

1. INTRODUCTION

Tests of neutron and gamma imaging using Lanex scintillator from Kodak have demonstrated that thermal neutrons have a contribution of about 40.4% at image formation. Thermal neutron intensity is about 1.22 x 10^5 n/cm^2/s, measured by gold foils activation method and for gammas was measured a debit dose of 740 mSv/h with a Teleprobe FH 40TG, when the mono crystal Bi filter is out of mixed beam of radiations. At the investigation of the structures with thick neutron absorbent and scattering layers it is advantageous to have a mixed registered beam of gamma radiations and neutrons to have a proper contrast of those materials in the complex structures with solutions, plastics, metals etc. An electrolytic capacitor contains rolled thin metallic layers and an electrolytic solution. This very tight structure is 3D revealed by this method of imaging.

2. EXPERIMENTAL METHOD

The experiments of neutron and gamma imaging for an old (made in 1984) Siemens electrolytic capacitor of 300000 μF, 15 V are performed at the INUS imaging facility built at the tangential channel of the TRIGA Annular Core Pulsing Reactor (ACPR), from the Institute for Nuclear Research (INR), operated in steady state mode at a power of 100 kW [1,2].
It is involved a classical transmission method with penetrating radiations, thermal neutrons and gamma radiations, that are registered on a proper scintillator. Further, the scintillations are integrated on an EM-CCD sensor of a camera that delivers a digital image to the storage disk of a PC. The tested object is placed on a rotary table in the front of the scintillator. Next are captured projections of the object from 400 positions/180^0. Octopus 8.9 software is used to obtain slices of the capacitor volume by tomography reconstruction. VGStudio Max 3.0 is used to obtain valuable 3D presentations of the capacitor structure by segmentation and animation.
The detector of the INUS has two interchangeable scintillators, a ^{6}Li-ZnS scintillator for neutrons and a Ga_2O_2S:Tb type (Lanex from Kodak) primarly for gamma radiations but sensitive to neutrons also. An EM-CCD Hamamatsu C9100-02 camera with a Xenon 0.95/25 mm lens is used. There are involved both scintillators to have a comparison between results obtained only with neutrons on ^{6}Li-ZnS scintillator and only with gammas or with both types of radiations on Lanex scintillator.

3. RESULTS

After image processing of the three sets of image projections of the capacitor on scintillators are presented 3D relevant reconstructions of internal structure of the capacitor (slices, segmentations, instances from animations

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etc.). A comparison between these results is done with the evidence of the advantage of registering neutrons and gammas together on the same scintillator for a better contrast of the image that offers enhanced information about internal structure of this old capacitor (metallic sheets positions, homogeneity of the electrolytic etc.).

References

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