実験報告書様式(一般利用課題・成果公開利用)

(※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。)

MLF Experimental Report

提出日 Date of Report

課題番号 Project No.
2014A0151

実験課題名 Title of experiment
Estimation of cadmium distribution in a picture by the neutron resonance absorption radiography

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実施日 Date of Experiment
16-17, May, 2014,

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

1. Standard: each 6 kinds of pigments of yellow, red and green with or without Cd, which were analyzed by INAA at KUR, was prepared on pure Al sheets of 10 mm^2. Also, metal sheets of Cd (25 μm in thickness) and Ti (1 mm) were prepared. They were put on pure Al plate of 100 mm^2 for irradiation.
2. Samples-1: in this category, the pictures were only one or two layers visible from surface. It means the picture has no hidden drawing. The sample number was 4.
3. Samples-2: in this category, 2 pictures hid drawings under the surface layer.

The samples-1 and samples-2 were drawn on hemp canvases or shells. And the oil or acrylic pigments of several colors were used for painting, which included the standard pigments. Also, Au sheets were used in some parts of the 4 paintings.

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。)

Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Experimental

1) The samples were covered with Al foil, and were hanged on the center of the neutron beam line. Neutrons were measured via a μ-PIC base neutron imaging detector (μNID) at downstream of the samples.
2) Neutron transmission images of 5 kinds of samples in the category ‘Samples-1’ and ‘Samples-2’ and that of standard were obtained via an imaging system consisting of a cooled CCD camera, a image intensifier and a ZnS(^{6}Li) flat scintillator. In addition to white neutron beam, radiographs with 0.1-0.3 eV neutrons were obtained by synchronizing the image intensifier to the neutron flight time corresponding to the neutron energy.

Results

1) Neutron energies depending on transmission rates were measured by the μ-NID through the standard sample. But expected neutron images were not obtained. The reason was considered that the amounts of pigments in

2. 実験方法及び結果（つづき）Experimental method and results (continued)

each depth of sample were not enough for the poor counting rate of the detector, even though Cd has high sensitivity and the pigments included Cd in high concentration.

2) Sample-1 (Category 1): Fig.1-a shows a photo of the sample-1, Fig.1-b shows the image by the white beam; 7meV-0.3eV, and Fig.1-c shows the image by 0.1-0.3eV neutrons. Both of neutron images were sum up of 10 images, and the gray range of the images corresponds the neutron transmission rate of 0.9-1.05. The difference of Cd concentration in the 3 kinds of Cd-green region was observed, and the Cd-yellow region was found to include high concentration of Cd compared to those of the Cd-green. It was also found that Au was transparent in the 0.1-0.3 neutron image.

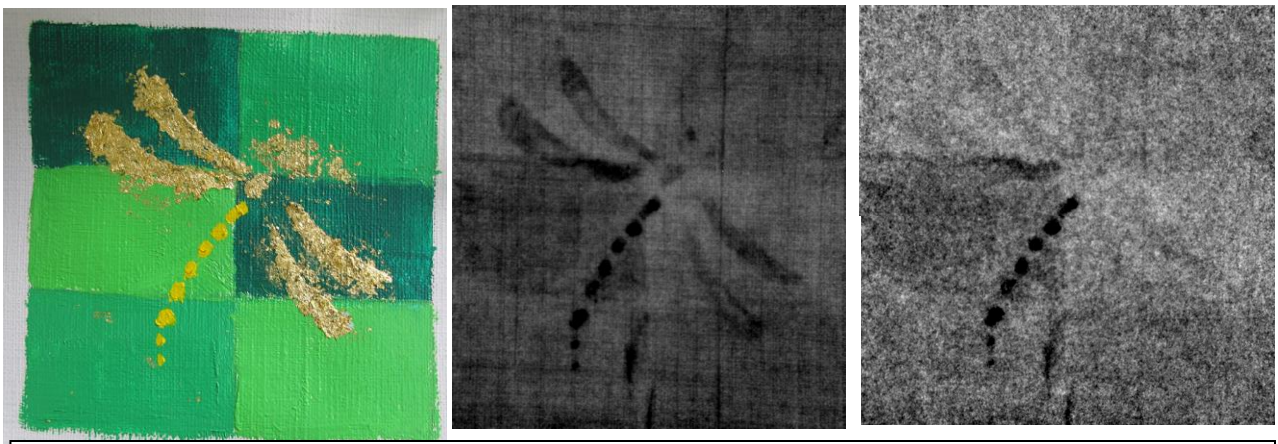

Fig.1-a Photo of Dragonfly	Fig.1-b Neutron image with white beam	Fig.1-c Image with 0.1-0.3 eV neutrons

3) Sample-2 (Category 2): Fig.2-a shows a photo of the sample-2, Fig.2-b shows the image by the white beam; 7meV-0.3eV, and Fig.2-c shows the image by 0.1-0.3eV neutrons. Other factor was same as above. This shell had hidden layer in which painted Milky Way with Cd-yellow and Au. By using the CCD camera base neutron radiography system, it was found to be easy to get neutron images for the under layer. After getting images of the under layer, it is necessary to analyze elements of the layer. The resonance neutron radiography is a powerful technique to obtain information of element distribution. A good imaging detector having both high spatial resolution and high counting rate was found to be indispensable for TOF analysis.

Fig.2-a Photo of Flower on a shell	Fig.2-b Neutron image with white beam	Fig.2-c Image with 0.1-0.3 eV neutrons