CO8-1 Transmission Electron Images Using ^{204}Tl

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INTRODUCTION: Transmission positron images have been obtained at Teikyo University of Science and Technology using a sealed ^{22}Na of 100 micro Ci. At Research Reactor Institute, Kyoto University (KUR), we obtained transmission electron images using ^{204}Tl. ^{22}Na emits “white positrons” (beta plus decay) and ^{204}Tl emits “white electrons” (beta minus decay). At KUR, 200 kV transmission electron microscope was also used to obtain up to 200 kV transmission images. The PSL/electron is measured as a function of acceleration voltage.

EXPERIMENTS: An imaging plate was placed instead of a film in the electron microscope at KUR.

RESULTS: Figure 1(a) shows imaging plate image. The value of PSL is the sum of PSL value over all pixels on one sheet of an imaging plate. The number of electrons arriving imaging plate is calculated as

$$N\mathrm{e} = (\mathrm{Current}) \times (\mathrm{Exposure\ time}) / e$$

Where e is the electric charge of an electron =1.6 x 10^{-19}[C]. The acceleration voltage was 14.12 kV, current was 3.97 pA, exposure time was 8.55s, PSL=4.53×10^6.

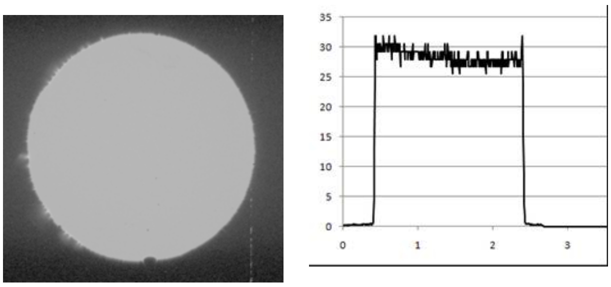

Fig. 1. (a) (b)

The vertical axis of Fig. 1(b) is the sum of five PSL values every 0.001 mm. The vertical values are almost constant (slightly decreased).

Figure 2(a) shows example of a positron beam (15 keV) intensity distribution perpendicular to the beam at TOF (Time Of Flight) at the Slow Positron Facility, KEK. 50μm X 50 μm/pixel was used.

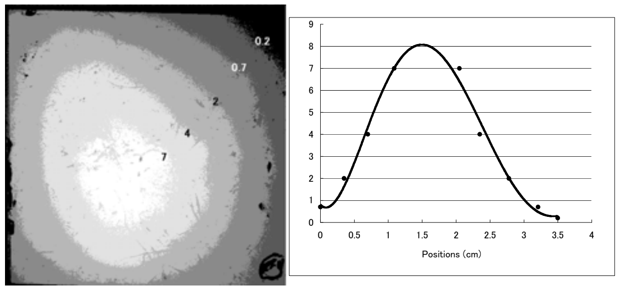

Fig. 2. (a) (b)

Figure 2(b) is the positron intensity across the centre. Positron beam (15 keV) intensity distribution perpendicular to the beam. PSL is plotted along the diagonal line in (a).

Figure. 3 shows the relation between PSL/*N*e and *V* (Acceleration voltage). The relation can be expressed as

$$\mathrm{PSL}/N\mathrm{e} = 5.66 \times 10^{-3}\,(V)^{1/2}$$

The solid line in the figure is a fitted one of above empirical formula to the experimental results. The fitting is satisfactory and PLS value normalized by the electron number seems to be proportional to the square root of the kinetic energy of electrons.

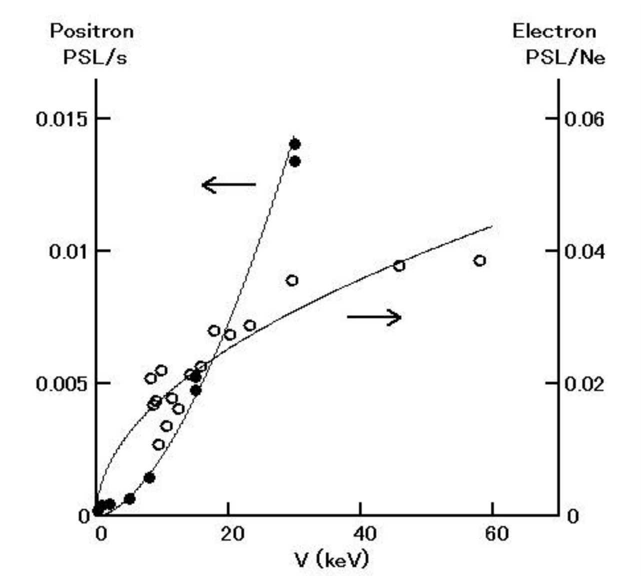

Fig. 3. Plot of PSL/Ne for electrons and PSL/s for positrons against acceleration voltage.

採択課題番号 22026 204Tl と透過型電子顕微鏡を用いた電子画像 共同通常
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CO8-2 Catalytic Decomposition Characteristics of Satellite Propulsion Thruster Using Neutron Radiography Technology at Kyoto University Research Reactor Institute (KUR)

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INTRODUCTION: Most mono-propellant thruster technologies were developed in the 1960s and the basic principles and fundamental structures, such as the catalyst and propellant, have been used without major technical innovation. Conversely, much remains to be identified in terms of the concrete mechanisms and quantitative limitations of the phenomena inside the mono-propellant thruster. One of our studies to improve the reliability of propulsion systems involved visualization, facilitating the direct observation of the physical and chemical phenomena which take place within the catalyst bed of the mono-propellant thruster[2][3][4]. In this paper, we introduce the visualization test results of the mono-propellant thruster utilizing Neutron Radiography.

EXPERIMENTS: The 1N thruster, which was observed by neutron radiography technology, was prepared by IHI Aerospace and used for JAXA's satellite propulsion system. The carrying 1N thruster operation equipment was set up to observe the 1N thruster real operation. Figure 1 shows a test schematic of the neutron radiography hot firing test.

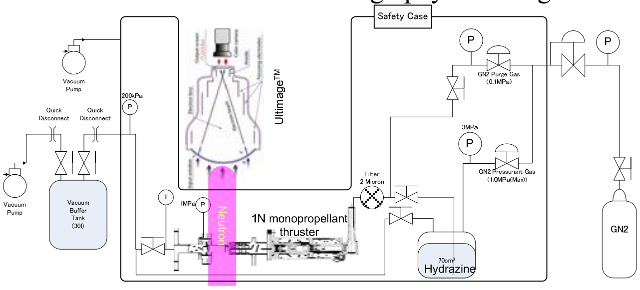

Fig. 1. Test schematic of the neutron radiography hot firing test.

The 1N thruster uses mono-grade hydrazine, which is injected into its catalyst bed and de-composited into hot gas. Hydrazine is considered to decompose in catalyst beds based on the following successive reactions:

$$3N_2H_4 \rightarrow 4NH_3 + N_2 + 3484J/gm$$

$$4NH_3 \rightarrow 2N_2 + 6H_2 - 1910J/gm$$

It is difficult to observe the low density molecular hydrogen behavior by X-rays in a dense metal chamber. On the other hand, the neutron radiography, which can visualize hydrogen atomic element more clearly than metal atomic element was expected to show the molecular motion of the hydrazine decomposition behavior in the catalyst bed [1].

We prepared Toshiba Color Neutron Image Intensifier (I.I.) (Ultimage^{TM}) as a neutron image detector. Its view area and resolution are 23 × 15mm and around 4μm / pixel, respectively, which can be zoomed up to about 13 × 9mm and around 2.3μm / pixel, respectively. At KUR, the actual neutron radiography resolution was measured as 12.5μm using an ASTM indicator. The observation unit was installed between the I.I. and KUR B-4 imagining port.

The test unit over view **The detector**

Fig.2. Shooting sample of the neutron radiography.

RESULTS: Shooting of neutrons at KUR was conducted by using real hydrazine propellant and the simulated 1N thruster. The images taken show the hydrogen liquid and hydrazine decomposition phenomena. The neutron flax was higher than that of the JRR3M JAEA MUSASI-H port, which provided fewer noise images and a shorter exposure time to take the neutron radiography images. However, the image resolution was prone to decline with increasing distance of the shooting object from the color I.I. imaging plane, due to the poor quality of the neutron beam.

A clear image could be taken by setting up the object closely to the color I.I. imaging plane.

The result of shooting the inside of the 1N thruster shows that the neutron radiography can observe the hydrazine decomposition phenomena and that the injection pressure affects the hydrazine decomposition point of the 1N thruster catalyst bed. Figure 3 shows the hydrazine decomposition point marked by the red circle in the catalyst bed slightly moved to the downstream of the catalyst bed.

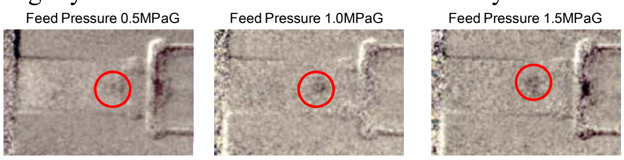

Fig. 3. Images of hydrazine injection.

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採択課題番号 22068 京大炉（KUR）を利用した人工衛星用触媒分解特性の可視化技術に関する研究 プロジェクト

（京大・原子炉）川端祐司、齊藤泰司、関本 俊（JAXA）香河英史、齊藤憲吉
（東芝）日塔　光一、小長井　主税（IIC）岩田　嘉道