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# Development of the Decladding Machine for Preparing a Density Measurement Specimen from the Irradiated Metallic Uranium Nuclear Fuel

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## 1. Introduction

It is a very important matter to invent or develop the advanced hot-cell equipment of cutting and preparing a specimen easily from the irradiated nuclear materials, especially fuels. In general, the properties of the irradiated materials, such as the ultimate strength and the hardness, are increased, so called hardening, as well as the absorb energy and the elongation are decreased, so called irradiation embrittlement. Because of hardening and irradiation embrittlement, a kind of hard work for preparing a specimen was often occurred.

In case of evaluating the swelling of the irradiated nuclear fuel, first of all the density measurement will be carried out in the hot-cell. For the irradiated PWR fuel, it is easy to make a specimen for density measurement because pellets were inserted into cladding tube. But in case of handling the irradiated metallic uranium nuclear fuel, such as HANARO, SMART and U-Mo, it is very difficult to prepare a specimen since the uranium meat is extruded with cladding material at the same time.[4,5,6]

At first the capsule cutting machine, which is installed in the M2 hot-cell, was used to prepare a specimen from the irradiated metallic uranium nuclear fuel for density measurement[1,2,3], however, this work was failed. Since the decladded specimen includes the fragments of cladding material after work as well as the fuel rod is broken easily during preparation work by reason of irradiation embrittlement.

In this work, the advanced hot-cell equipment of a decladding machine from the irradiated SMART and HANARO nuclear fuels is developed and tested.

## 2. Experimental

The dimensions of a decladding machine, as shown in Fig. 1, are 200 mm in width, 500 mm in length, 230 mm in height, and about 20 kg in weight. It consists of a mounting assembly part for work piece, a cutting assembly part, and a basket for chip. The mounting assembly part could be mounted a work piece up to maximum 10 mm in diameter with less than 200 rpm and a feed speed is 0.05 mm per cycle with maximum 7 mm in distance. The cutting assembly part is equipped with three(3) HSS bites with 120 degree interval and a feed speed is 0.05 mm per cycle with maximum 7 mm in distance.

A work piece was chucked to the mounting assembly part with less than 10 mm in length by a master-slave manipulator. Three(3) HSS bites are adjusted to compare with the distance or diameter of a work piece by rotating the cutting assembly part counterclockwise by a master-slave manipulator, too. Power on and rotate a handle of cutting assembly part clockwise by manually to cut a work piece until finishing the decladding work as shown in Fig. 2.

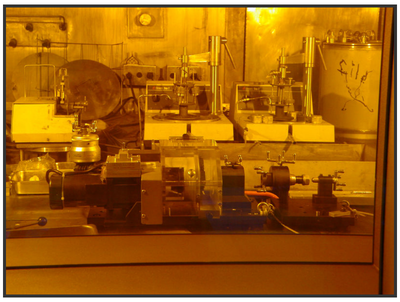

Figure 1. The appearance of a decladding machine for irradiated nuclear fuel.

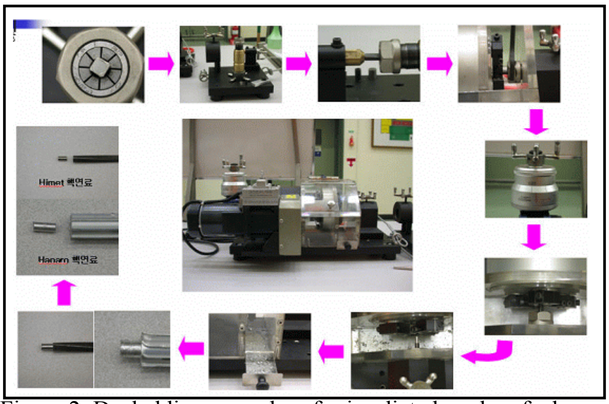

Figure 2. Decladding procedure for irradiated nuclear fuel.

## 3. Results

### *3.1 Decladding the irradiated metallic uranium nuclear fuel*

The metallic uranium nuclear fuel was irradiated at HANARO during thirteen(13) months with 0.3 g/cc(95 at%) in burn-up and 342.7 W/cm in linear power. This fuel was transported to IMEF after cooling it at HANARO maintenance pool on April 2004. It was decided to cut two(2) maximum and minimum axial burn-up points, which is used to evaluate the swelling, after getting the gamma scanning examination results. It was cut by the decladding machine at the M3 hot-cell, and obtained the optimum revolution value of 100rpm for a mounting assembly part. This optimum revolution value implies consideration for hardening and irradiation embrittlement by neutron radiation. The result is described in Fig. 3.

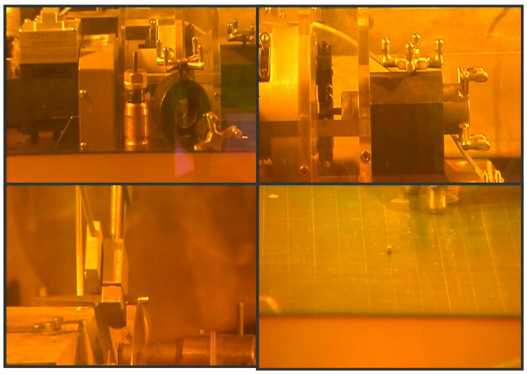

Figure 3. The result after decladding the irradiated metallic uranium nuclear fuel at the M3 hot-cell in IMEF.

### *3.2 Observation of the surface for Decladded specimen*

The decladded specimen was cut by micro-cutting machine at M3 hot-cell to take a specimen for density measurement. And this specimen was transferred to M7 hot-cell to observe the surface by Hi-scope whether the cladding material is contained or not. The observation results are shown in Fig. 4. As shown in Fig. 4, None of the fragments of cladding material was found.

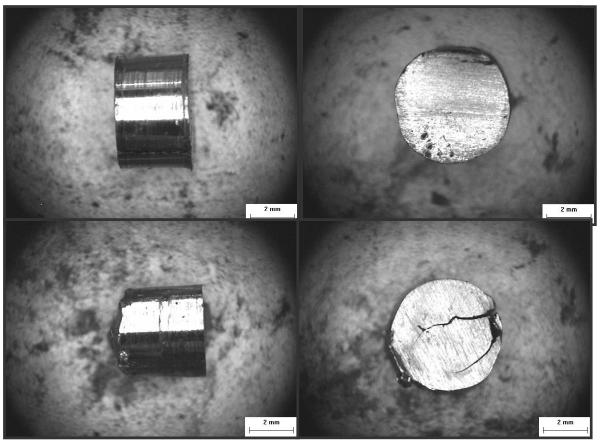

Figure 4. Observation results after decladding the cladding material of irradiated metallic uranium nuclear fuel.

## 4. Conclusions

The decladding machine was successfully invented and developed to prepare a specimen of density measurement for evaluating the swelling of irradiated metallic uranium nuclear fuel, which is extruded uranium meat with cladding material at the same time. The optimum revolution of a mounting assembly part is 100 rpm with consideration for hardening and irradiation embrittlement by neutron radiation. The decladded surface was observed by Hi-scope, and none of the fragments of cladding material was found. This work is useful for preparing a specimen for the density measurement of the irradiated metallic uranium nuclear fuel as well as for supporting the R&D program of research groups, industrial companies, and universities.

## REFERENCES

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