Development of Specimen Traceability Technology in Hot Cell

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1. Introduction

The irradiated specimens are treated only by manipulator in hot cell due to radioactivity of specimens. The fabricated specimens have various sizes and complex shapes according to the fabricate conditions. Most specimens from HANARO and surveillance capsules of NPT have identification numbers on the outer surface. However, specimens fabricated in hot cell don't any identification number. Therefore the traceability of the specimen is often lost by mixing the specimens together. One way to prevent this traceability loss is to mark the specimen with identification number on it. Eventually, even if a number of specimens are handled/tested in a hot cell, they will be able to be distinguished from each other by their unique identification number.

2. Methods and Results

One of the most important thing was securing remote control. All the equipment in the hot cell had to be operable with the manipulator because the space where the equipment is located (hot cell) and the space to be controlled (working area) had to be separated. For this reason, all cable and laser fiber had to be made over longer than 5 m and their function had to be maintained over extended length. The specimen traceability machine was designed in three parts. The laser oscillator which serves as a laser source, the laser controller system that can control this laser, and the scanning head system was used to mark the specimens.

First, the laser oscillator has been surveyed through several commercial oscillators and the YLP-V2-100-20-20 model has been selected based on the advice of the laser experts. The detailed information is shown in Fig. 2.

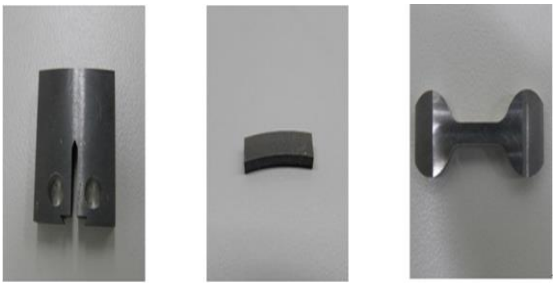
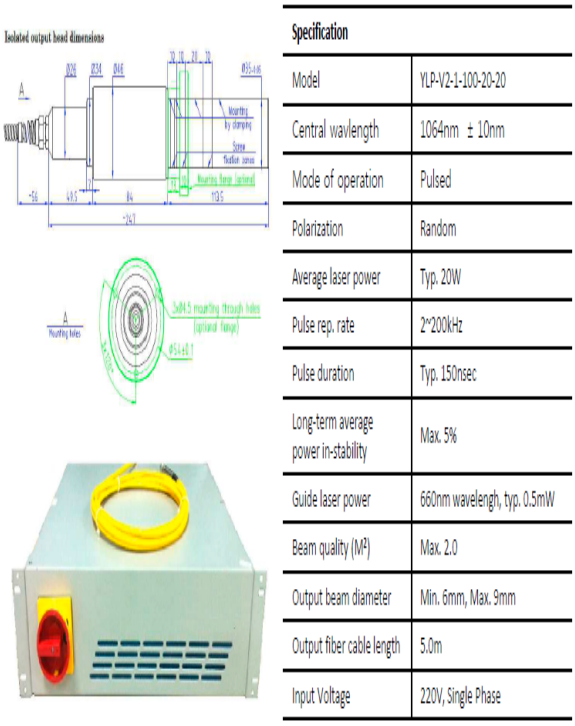


Fig. 1. Various type of specimens used in hot cell.



Specification	
Model	YLP-V2-1-100-20-20
Central wavlength	1064nm ± 10nm
Mode of operation	Pulsed
Polarization	Random
Average laser power	Typ. 20W
Pulse rep. rate	2*200kHz
Pulse duration	Typ. 150nsec
Long-term average power in-stability	Max. 5%
Guide laser power	660nm wavelengh, typ. 0.5mW
Beam quality (M^2)	Max. 2.0
Output beam diameter	Min. 6mm, Max. 9mm
Output fiber cable length	5.0m
Input Voltage	220V, Single Phase

Fig. 2. The specification of laser oscillator.

Next we figured out how long all the cable to use the oscillator could be extended. As a result, if the laser cable length (optical fiber) is more than 5 m, the performance of it cannot be guaranteed. Thus, the length of the optical fiber, the power cable and data communication line were made to fit 5 m. The place of the equipment in the hot cell was also positioned accordingly.

Second, we designed a laser controller system. The hardware was equipped with a RTC5 board which can be real-time controlled and marked on the specimen as it is sketched in the working area. Because there is no software optimized for hot cell, we customized the software with help of specialized company. The software was designed to correct distortion of F-theta lens in scanning head, set the desired scanning area for laser marking and implement most functions of word processor including font size, style, rotation and alignment.

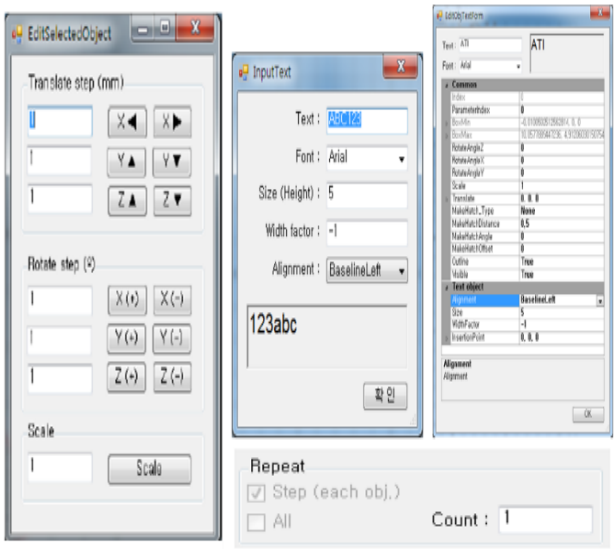


Fig. 3. The customized software for laser marking system.

Third, we designed a scanning head system that launched a laser to mark the irradiated specimen. The system fixed the head which emits the laser generated from the oscillator. Therefore, we designed it as simple and light as possible an. An additional F-theta lens was attached to the scanning system and the distance between the lens and the specimen (focal length) to be marked was 167.2 mm. Therefore, the height of the scanning head was designed to be 300 mm considering the height of the specimen, jig and specimen holder. And we tried to make a support table which can adjust the height of the jig. In this process, laser marking machine system has been constructed to ensure traceability of the irradiated material (Fig. 4.). A laser controller was installed on the left first floor, a laser oscillator was installed on the left second floor and a scanning head system was installed on the right. We prove its performance through laser marking on un-irradiated specimens.

Fig. 4. Laser marking system in cold lab.

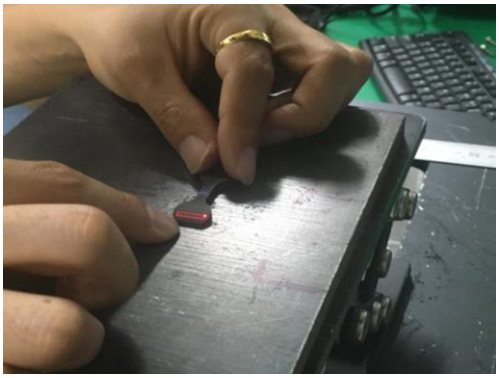


Fig. 5. Simulation with red guide beam before actual marking.

In addition, laser marking machine was designed to be able to simulate with red guide beam before marking on specimen, it was made to minimize the failure in actual marking (Fig. 5.).

3. Conclusions

Specimen traceability technology was introduced to verify the identities of irradiated materials in a hot cell. Various types of un-irradiated specimens were tested successfully (Fig. 6.) and this technology will be modified and developed for the tracking of irradiated specimens in the hot cell.

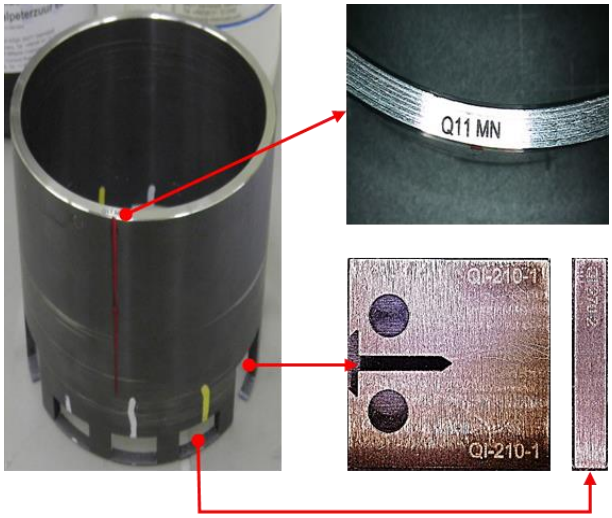


Fig. 6. Various types of specimens with identification numbers after laser marking.

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[2] Y.G.Jin, G.S.Heo, G.S.Kim, Y.M. Jung, H.M. Kim, "Development of Laser Marking System in Hot Cell", KNS spring meeting, 2018