# Light ablation decontamination characteristics of metal specimen contaminated with simulated radionuclides at 532 nm

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## 1. Introduction

A laser ablation decontamination technology which is reported as a new and innovative technology has been developed to secure an appropriate decontamination technology for a refurbishment or a decommissioning radioactive hot cells in Korea. In the present study, we investigated the basic performances of a Q-switched Nd:YAG laser system with a second harmonic generation (532nm) in the decontamination of the metal specimens contaminated with simulated radionuclides. The surface morphology and the relative atomic mole percent ratio of the specimen surfaces were investigated by using SEM and EPMA.

## 2. Methods and Results

### 2.1 Specimen Preparation

Type 304 stainless steels were cut into a rectangular form to prepare the experimental specimens. They were polished with abrasive papers, and washed with water and ethyl alcohol. The specimens were contaminated as follows: $Eu_2O_3$ powder (Aldrich Chemical Company, inc) mixed with distilled water was slowly dropped onto the surface of stainless steel by injection and then dried in a room temperature. Two kinds of $Co(NH_4)_2(SO_4)_2$ and $CsNO_3$ solutions were also dropped onto the specimen surfaces, respectively and then dried for the test. The relative atomic molar percent of surface elements before laser irradiation was analyzed by EPMA (JSM-6300).

### 2.2 Laser irradiation

A Second harmonic generation Q-switched Nd:YAG laser was employed. Fig. 1 shows the schematic diagram of the experimental apparatus.

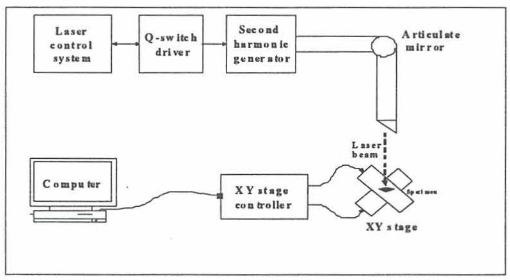


Fig. 1. Schematic diagram of the experimental apparatus.

### 2.3 Test results

Removed weight of the metal specimen at 1Hz of repetition against the shot numbers under three fluence conditions is shown in Fig.2.

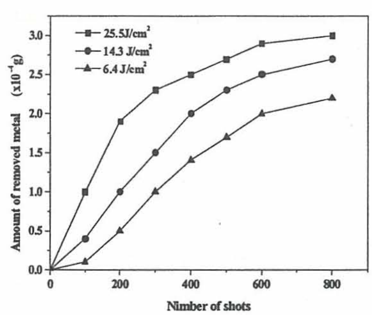


Fig. 2. Relationship between the removed metal weight and the shot numbers.

The amount of removed metal is increased with the shot number at a given fluence. The values of the apparent removal rate are $1x10^{-6}$, $4x10^{-7}$, and $9x10^{-8}$g/shot at 25.5, 14.3, and 6.4mJ/cm$^2$, respectively. Also amount of removed metal increased with fluence at given number of shot.

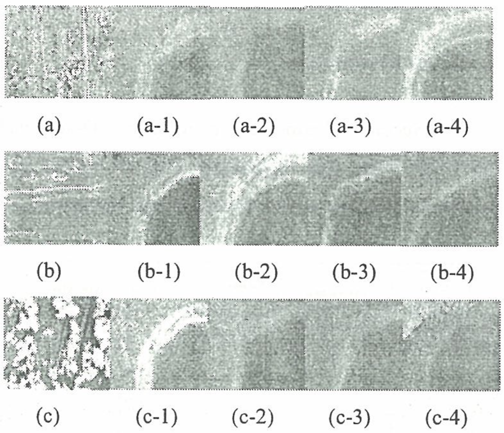

Fig. 3. SEM images of SUS 304 surface (50X) contaminated with (a) $CsNO_3$ ;(c) $Eu_2O_3$; (b) $Co(NH_4)_2(SO_4)_2$ before and after 8 laser shots of laser irradiation at 1:0°, 2:15°, 3:30° and 4:45°.

The exposed specimen morphology was examined by SEM at a magnification of 50X. SEM micrographs of the specimens before and after 8 shots, laser energy fluence 14.3J/cm$^2$ of laser irradiation at a given angle for the 0°, 15°, 30°, 45° are shown in Fig.3. Here, (1), (2), (3) and (4) are the specimen irradiation angle for 0°, 15°, 30° and 45° respectively. As shown in Fig 3 (a), (b) and (c) contaminants on the metal surface were evenly attached and connected with each other. From the EPMA analysis it was found that $Co^{2+}$ and $Cs^+$ ions are included in a crystal. On the other hand, as shown in Fig. 3(c), $Eu_2O_3$ powders are dissipated. Comparing the former study [1], the effected surface was smooth irrespective of the change of irradiation angle from 0 to 45°. From the figure, the stainless steel surface was slightly melted and it formed different shape of crater by the change of irradiation angle. It can be seen that the crater is formed elliptical shape. The removal efficiency was worse at 45°.

## 3. Conclusion

Laser decontamination tests of the surrogate specimen was performed to evaluate the light ablation performance. Simulated radionuclides on the metal specimens were removed satisfactorily by the laser ablation method. The ablation depth was around $1x10^{-6}$ g/shot at 25.5J/cm$^2$. The increase of laser fluence increased the laser ablation depth. The results indicate that the secondary generated from the ablation metal of stainless steel is negligible. From the result, the irradiation angle from 0 to 30° was most suitable.

## 4. Acknowledgement

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## 5. REFERENCES

[1] B. Baigalmaa, H. J. Won, J. K. Moon, C.H.. Jung, and J. H. Hyun, "A comprehensive study on the laser decontamination of surfaces contaminated with $Cs^+$ ion", Appl. Radiat.. Isotopes, Vol. 67, pp.1526- 152 9, 2009.