Development of CW fiber laser decontamination using high-speed scanning of high-power density laser beam

～Understanding the laser decontamination mechanism～

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Abstract

The nuclear accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company following the Great East Japan Earthquake that occurred on March 11, 2011, released large amounts of radioisotopes, causing severe environmental pollution. In addition, large amounts of radioactive wastes consisting of contaminated materials will be generated due to the decommissioning of the reactors. Decontaminating using appropriate methods and reducing the amounts of the radioactive wastes to be stored can significantly reduce storage costs.

Conventional decontamination methods, such as chemical and mechanical ones, have disadvantages; the workers are likely to be exposed to radiation, and a large amount of secondary waste is generated. The decontamination using laser technology has several significant advantages. The laser decontamination enables remote work. In addition, since the laser decontamination is intrinsically the non-contact decontamination, the generation of the secondary wastes can be significantly reduced. However, in many traditional laser decontamination methods, the device that peels off even the base material has not been considered. On the other hand, whenever a high-power density laser is used, the heat from the laser irradiation is concentrated on the metal surface and melted so that the radioisotopes may permeate the bulk material. Consequently, the radioisotopes that remained in the melted part are considerably uniformly distributed, and a higher decontamination factor cannot be obtained.

The purpose of the study is to clarify the metal decontamination processes using focusing the CW fiber laser on a small spot diameter and scanning the laser spot at high speed to minimize melting locally or to realize no melting of the metal surface and to evaporate instantaneously [1]. For the purpose, the metal surface has been irradiated with the CW fiber laser, and the state of the surface peeled off has been measured. Furthermore, the states of the metal surface during laser irradiation have been observed by using a high-speed camera. Additionally, we also report on the results of the laser decontamination field trials of equipment parts contaminated by the Fukushima Daiichi accident [2].

References

[1] Minehara EJ. A New Laser Decontamination Device. The Review of Laser Engineering. 2012; 40:p.165-170.
[2] 小菅 淳, 峰原 英介, 猿田 晃一. 高出力密度レーザー光の高速掃引を用いた連続波ファイバーレーザー除染の開発. 日本原子力学会 2022 年春の年会, 3C03