Latin America Optics and Photonics (LAOP) Conference 2022 © Optica Publishing Group 2022

Study on the Potential of Laser Ablation to Decontaminate Radioactive Waste

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Abstract: Laser is a promising tool to decontaminate radioactive waste that is impregnated with radionuclides on its surface, the decontamination process has no chemical inputs, and the pollutants can be fixed in HEPA filters. The current study aimed to test a wide range of samples using 10 different materials and fluences ranging from 1 to 10 J/cm^2.

1. Introduction

There are few efforts to demonstrate the viability of laser decontamination for radioactive waste decontamination [1-3]. The laser ablation has advantages over the aforementioned methods such as being quick to apply [12] and no need to apply chemical or abrasive inputs [1]. There is, however, a gap in information that resulted in different studies applying different materials and laser parameters.

The objective of the present study is to evaluate a variety of materials being decontaminated with the same laser parameters.

2. Material and Methods

A Nd:YAG operating at 1064 nm with pulse duration of 5 ns and 20Hz of repetition rate was used. A focusing lens of 12.5cm of focal length delivered 3 fluences (1, 5 and 10J/cm^2) on metallic and polymeric samples which were previously dripped with a solution with (5.06±0.30) kBq.mL^{-1} of activity containing ^{137}Cs. The superposition of pulses was set as 50%. The experimental setup is illustrated in Fig 1.

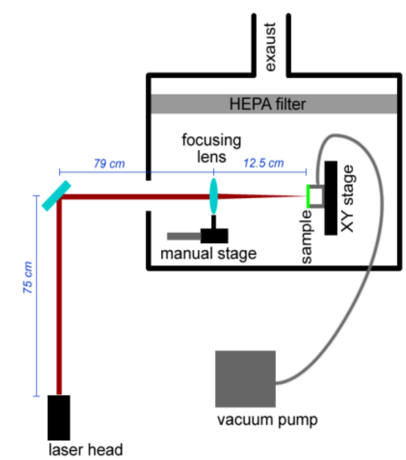

Fig. 1. Laser beam in injected into a fume box, and focused on the sample surface. A XY translation stage was used to move the sample, providing the coverage of all surface.

3. Results and Conclusions

The 1 J/cm^2 fluence was not effective, and for 10 J/cm^2 in most of the cases reaching more than 95% of activity removal, Fig 2. Therefore, the range from 1-10 J/cm2 reached both ends. 5 J/cm^2 showed a good balance between decontamination and fluence, presenting results not far from the 10 J/cm^2 case. As the acrylic sample was transparent, the laser interacted weakly with its surface, leading to a poor material ejection.

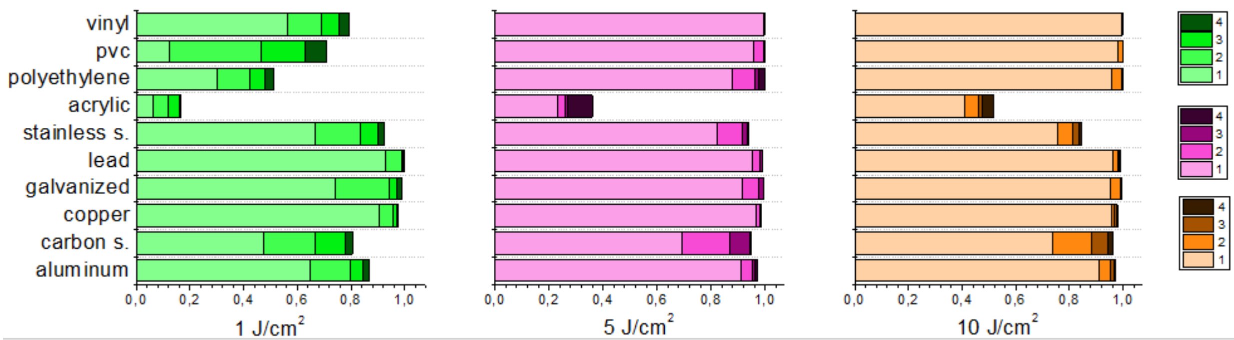

Fig. 2. The normalized and cumulative decontamination (from 1 to 4 irradiations rounds) for 3 different fluences and 10 different materials.

Nonetheless, especially in metals, was observed residual contaminations that seem to be due to the incorporation of the radionuclides by the Marangoni currents [4-5], demanding now further investigation.

6. Acknowledgments

The authors acknowledge the fellowship awarded by the Brazilian National Nuclear Energy Commission to P. Costa, and the support given by the Brazilian National Council for Scientific and Technological Development (CNPq) grants 422484/2016-4, INFO 465763/2014-6 and also from Sisfoton (CNPq 440228/2021-2).

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