82803

Research Objective:

The objective of this project is to develop a novel laser ablation in liquid for surface decontamination. It aims to achieve more efficient surface decontamination without secondary contamination. Another aim is to make this surface decontamination technology becomes economically feasible for large scale decontamination.

The major goals are as follows.

1. To develop novel **Laser Ablation Decontamination in Liquid (LADIL)** technology for safe removal of radioactive and/or toxic contaminants from a surface without producing dangerous secondary pollutants.

2. To obtain a data base for the basic physical processes of laser ablation on a solid-liquid interface and use the results of this basic study to improve the cleaning efficiency of surface-contaminated materials.

3. To optimize the cleaning process for efficient recycling of contaminated materials.

4. To evaluate the feasibility of LADIL for large scale surface decontamination.

Research Progress and Implication:

After approximate 2 year of a 3 years project, we have designed, installed and tested the facility for laser ablation in liquid for surface desorption. During the past year, we have demonstrated and evaluated surface decontamination with laser ablation in solution. The mechanism for desorption was also carefully studied.

During the past year, we have pursued laser ablation in liquid for surface decontamination with laser wavelength ranging from UV to IR. We found laser wavelength is not a critical factor for surface decontamination if the liquid solution is transparent to the laser wavelength. Since in most waste sites, the solution almost always contain various materials which tend to absorb UV beam, the wavelength preferred to be used is in near UV or visible region. We have also found laser induced acoustic desorption can enhance overall desorption efficiency. With the help of optical acoustic desorption, the overall efficiency can be increased by 30%. Our study of the ablation of absorbing liquids showed that the surface tension and fluctuation of the acoustic field causes formation of micro-droplets with an average radius 5 to 10 µm which varies with the laser fluence used for irradiation. Similar to ablation at a liquid-air interface, ablation at a solid-liquid interface produces micro-particles rather than evaporation of the solid material. The average size of particles in water was found to be about 3.5 µm. The observation of particle desorption instead of molecule desorption indicates that the efficiency of desorption in solution ca be significantly increased compared to desorption in air. Furthermore, the micrometer size particles can be easily separated from the solvent by centrifuging. Thus the contaminants can be separated and stored in adequate storage area.

During the past year, we have been informed that many DOE sites have nuclear fuel pools with high levels of contamination. The pools are used for storing spent nuclear fuel. The fuel was very radioactive, and was contained in fuel rods. Many rods were placed in a basket with individual slots for each rod. They were put in the pool because water is a good shield for radioactivity. However, after a long period of time, the housing deteriorated and fuel leaked in the pool. Significant part of leaked contaminants precipitated at the top edge of the pool. Lowering the water level to clean this area during pool dismantlement allows the contaminants to become airborne at an unacceptable safety risk. We consider LADIL can have great potential to achieve decontamination of these nuclear fuel pool. During the past year, we have put significant effort in evaluating the feasibility for LADIL for nuclear fuel pool decontamination.

Since we are not equipped to handle radioactive materials, we tried to simulate the deposition of metals in water and found significant deposition of metal particles on the top edge of a metal beaker. We then designed an optical system to guide laser beam into water for surface decontamination without the need of putting any optics into water. Efficient decontamination was achieved with a Nd-Yag laser. The very preliminary results indicates it has potential to scale up for nuclear fuel decontamination.

Planned Activities:

During the coming years, we will put major effort to evaluate the feasibility of using LADIL for nuclear fuel pool decontamination. The major tasks will include the measurement of surface decontamination with different pH values. We will try to simulate the chemical environments of these fuel pool without radioactivity. An excimer laser beam will be used to check the desorption efficiency at high repetition rates. A model will be pursued to estimate the time and cost for decontamination of these pools with LADIL.

In addition to the study on the potential of fuel pool clean-up, we will continue to study the fundamental mechanism of laser desorption in liquid. They will include the optimization of laser power density for surface decontamination, the suspension times for farious particles at different sizes and desorbed particle size distribution.