STEPS Students Report

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I have visited the Institute of Laser Chemistry of St. Petersburg University in Russia for a duration of one month in October as a part of STEPS Program. I was accepted by Prof. Alina Manshina, who is one of the leading researchers in the laser deposition techniques. During my stay in Russia, I have learnt the different experimental techniques of related to the laser chemistry. Along with assisting the researchers, I have tried to deepen my understanding of the laser methods during the experiment. The knowledge and the experience gained during my exchange program is reported below.

LASER DEPOSITION TECHNIQUE:

Laser assisted techniques are of more importance since the beginning and are very important for metal deposition. These techniques allow metal precipitation on different kinds of materials but most of them are expensive. Laser induced chemical liquid phase deposition (LCLD) is considered among the others to be the most promising and efficient. The deposition process can be divided into three main stages. Firstly, catalytic centers are formed on a surface due to the local change of its electronic structure by laser radiation. Then, the metal ions are reduced on the formed catalytic centers. Finally, the reagents are transferred from the bulk solution to the reduction (irradiation) zone, which depends on the rate of diffusion and the rate of the catalytic reaction.

EXPERIMENT:

For the deposition of metallic phase by laser induced chemical liquid phase deposition the experimental setup with the substrate side geometry of the precipitation was used. The substrate side of geometry allows minimization of the negative effect of gas bubbles generation in chemical reaction. In this case, the substrate is fixed on the surface of the 3-mm-thick solution layer and the laser beam is focused on the substrate-solution interface from the side of the substrate. The scheme of the experimental setup with the “substrate-side” geometry is presented in Fig 1.

The sample was prepared by using cobalt acetylacetonate of 0.7mg with 1ml of ethanol. After taking the two components in a capsule, it is cleaned with ultrasonic

cleaner for 5minutes to remove any of the impurities present. The capsule is then shifted to the centrifuge with 10000rpm for 5minutes. Different radiation sources were used, namely blue laser with a wavelength of 374nm of power 16mW and red laser of wavelength 661nm of 100mW power, for deposition process. The sample was radiated with the laser for a maximum time of 80minutes but did not observe any visible deposition on the substrate. So, in order to observe the visible deposition on the substrate, different sample is prepared by taking the required amount (0.4mg, 0.6mg, 0.8mg) of hydro Salicylamide of Titanium and mixing with 1ml of solvent aceto phenone (C_8H_8O).

The blue laser generated in the multiwave regime was used for the metal precipitation by the LCLD method. The laser generates at the wavelengths 374 nm. The laser power was equal to 16 mW. Laser is incident on the substrate and is allowed for deposition. The deposition was observed on the substrate with the configurations as mentioned for the laser.

DISCUSSION:

The deposition of chemical on to the substrate thickened as the time of exposure to the laser increased. This enhanced deposition is due to the longer duration of exposure to the laser. The morphology and the chemical composition of the deposited structures were studied by SEM-SCAN 4 DV electron microscope equipped with the energy dispersive X-ray spectrometer (EDX), which was used for the chemical analysis.

S.No.	Concentration (mg/ml)	Symbol	Time (min)	Remarks
1	4	C1-1	40	No deposition
		C1-2	60	No deposition
		C1-3	80	Slight visible deposition
2	8	C2-1	40	No deposition
		C2-2	60	Slight visible deposition
		C2-3	80	Slight visible deposition
3	6	C3-1	40	Visible deposition
		C3-2	60	Better visible deposition
		C3-3	80	Thick visible deposition

Table 1: Showing the deposition results of laser deposition process

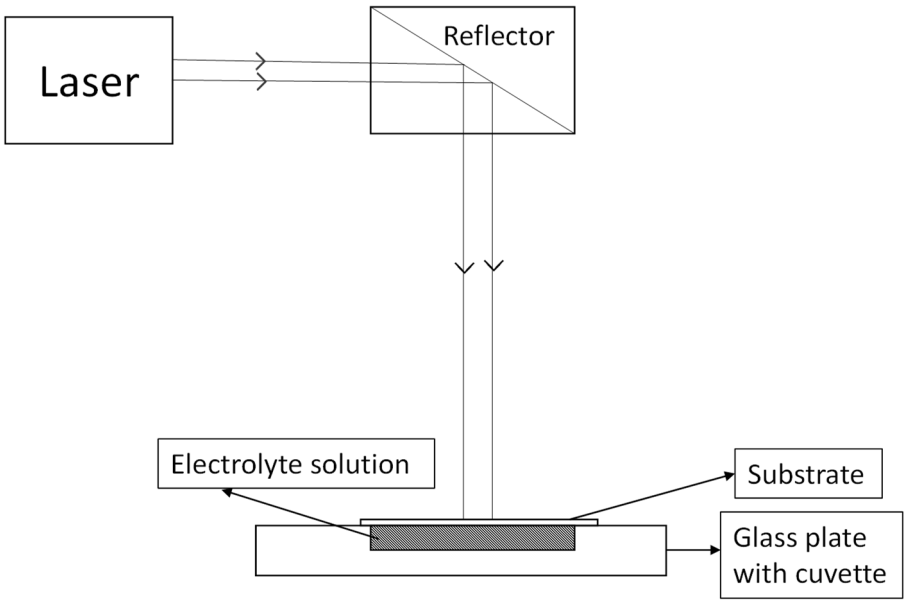
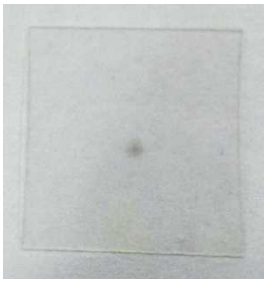


Fig.1: Experimental setup for the laser deposition process

Fig.2: (a) Glass Plate with cuvette.



(b) Thick deposition of sample C3-3.

(c) Slight visible deposition of sample C2-3.

Apart from the research, I have visited many different and beautiful places in St. Petersburg. I visited City Palace, Hermitage Museum, and Isaac's Cathedral during my weekends. Hermitage Museum and City Palace are very delightful to visit and they depict the history of Russia. The architectural, aesthetic views are marvelous and was spellbound after seeing them. Even though, the metro trains were built long way back (since 1955) they are comfortable. The architectural pathways in the metro stations mesmerized me a lot.

Fig.3 (a) St.Isaac's Cathedral

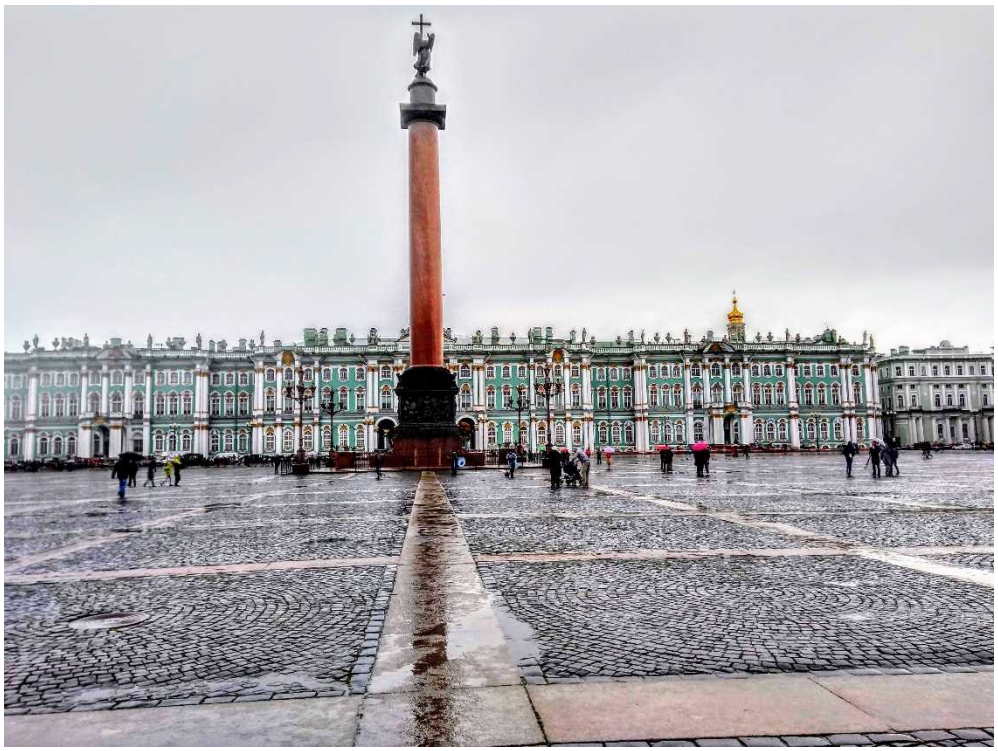


Fig.3 (b) St. Petersburg City