

World Center of Education and Research for Trans-disciplinary Flow Dynamics

Perfilyev Andrey

Khristianovich Institute of Theoretical and Applied Mechanics SB RAS, Russia

Research topic: Experimental investigation of functional TiO₂ coating formation using DC-RF hybrid plasma torch.

Supervisor: Professor Hideya Nishiyama, Institute of Fluid Science, Electromagnetic Intelligent Fluids Laboratory.

Duration: 18th September ~ 18th October 2012

My research topic in the Institute of Fluid Science is functional TiO₂ coating generation in a DC-RF hybrid plasma flow system by use of solution precursor plasma spray method (SPPS). First of all, I met with the team and learned basic research activities of the laboratory. Professor Nishiyama's group, in particular his Phd student Jang, has made good progress in the generation of C doped TiO₂ nanopowder, which is synthesized through SPPS in a DC-RF hybrid plasma flow system. TiO₂ is widely used photocatalytic material, but it is active only under ultraviolet light irradiation. It was shown that carbon helps TiO₂ to increase absorption of visible light irradiation therefore C doped TiO₂ is more attractive for commercial applications.

The SPPS is one of the liquid feedstock plasma spraying methods, where liquid usually is used for feeding and injection of ultrafine particles to be sprayed in plasma jet. But in SPPS the particles of material to be sprayed formed directly in plasma jet from the chemical precursors of material (titanium tetrabutoxide in our case) and after that they may be deposited on the substrate.

Because of the temperature field of the plasma flow is one of the key physical parameters in the coating process, we firstly measured this. After that we made some attempts to spray coating using abovementioned method on the copper substrate under various substrate placing. Coating patterns visually seems to be very distinct with those produced with conventional plasma spraying. The SEM photographs demonstrated that there are no any splats (flattened molten particles) in the coatings. All the coatings obtained consist mainly of near spherical particles without significant connections to each other and so the coatings are very porous. It should be noted that the deposition efficiency of such process is very low and accordingly produced coatings are very thin (approximately thickness is about several micrometers). Therefore it is impossible to measure adhesion of such coatings by the use of conventional test implying the glue using and so it is necessary to use another measuring technique. Raman spectra of all the coatings have very broad and intense peak of unknown phase (probably

amorphous phase) and only small peaks corresponding TiO_2 . However in the laboratory it is only the first attempt of TiO_2 coating generation by the use of DC-RF hybrid plasma system. Preliminary results obtained show the direction of further experimental activity.

This is my first visit to foreign country and my first experience of participation in the joint research work. I would like to say my heartfelt gratitude to Prof. Nishiyama and his group for these opportunities and for the hearty reception. I also would like to thank the staff of the GCOE office for the organization of this internship program.



Imoni party of Prof. Nishiyama's laboratory



Jang and I near the experimental setup



Okunikkawa - Yatsumori
Trip along the river



Prof. Nishiyama with me on the Sendai Station