

The Global COE Program

“The Next Generation of Physics, Spun from Universality and Emergence”

Bilateral International Exchange Program (BIEP, invite) report

Send report to: Your responsible Professor in Kyoto University

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(Year/Month/Day)___2012/11/22__

Invited Student

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Responsible Researcher in Kyoto University

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Research Project

Title	Periodic structures self-formed on the surface of semiconductors by femtosecond laser pulses
Duration	2012.09.15 – 2012.11.30

Please summarize your activities and results during your stay in Kyoto University.

Also please describe how your stay has been beneficial to the graduate students in the host institute. You can add a sheet, if you need more space.

You can also write any comments and requests to the GCOE program.

The main purpose of my laboratory activity has been to study the generation of periodic nano-structures on semiconductors as Silicon (Si) and Silicon Carbide (SiC) by irradiation with femto-second laser pulses. Indeed the increasing availability of ultra short pulse laser systems during the last years is reflecting the growing necessity of high quality and high reproducibility fabrication in several applications in the field of nano and micro-processing. Surface treatment by fs lasers permits to obtain different surface patterns in various materials with very localized heat affected zones in the irradiate volumes thanks to the

so-call non thermal interaction with the material. In this context, Laser Induced Periodic Surface Structures (LIPSS) self formation have been studied independently for dielectrics, semiconductors and metals. If LIPSS self formation is related closely to the presence of surface plasmas such a laser produced plasmas and solid-state plasmas, as suggested by the parametric decay model implemented by Sakabe group to describe the metal LIPSS behaviour, semiconductors under intense optical field would be classified as metals. Therefore it is significant to investigate the dependence of LIPSS generation on the laser fluence for semiconductor, to compare with the one for metals. Results suggest as a matter of fact that the LIPSS generation on semiconductors under intense optical field is closely related to the one observed for metals. The evolution of the nano-structure periodicity with respect to the laser fluence at high number of laser pulses falls into the region predicted by the parametric decay model . Other two features, i.e. the generation of periodic micro-structures at high fluences and the increasing of the periodicity with the decrease of the laser pulse number, have been found also in the case of metals. For instance, the generation of periodic micro-structures at fluences well above the ablation threshold fluence has been observed on Titanium. In addition, the observed evolution of the nano-structure periodicity with respect to the number of pulses for Si is already well known for different metals.

My laboratory activity has been carried on with the indispensable assistance of the students and researchers from the Sakabe Lab group, who made much easier my adaptation to the group activity and always showed a great patience and availability. In Sakabe Lab all the research activities of the graduate students are closely followed by supervisors and everyone is thus encouraged and stimulated to work as best as possible. Weekly discussions are carried on with all the group members. This way every student is involved not only in its own research project but can actively contribute to all the group activities and vice versa, bringing this way to very constructive and stimulating interactions. Therefore I can definitely state that my professional skills have been greatly increased in these months, in particular regarding the handling of new laboratory equipments, analysis instruments and more generally the management of a project within a strictly definite period of time in a new workplace. From this point of view, it is hard to describe which benefits my stay has brought to the group since I definitely feel I have learned a lot more than taught, except for a little English training I subjected the students to. The mutual curious interest from both the personal and the professional point of view between myself and the group made easy to build friendly relationships with each other also apart from the working environment. This way I found myself able to taste and enjoy a good part of the Japanese culture which I very much appreciated. Beyond being scientifically very experienced, Sakabe group surely is a very good example of the famous Japanese kindness and availability.