Call for applications for PhD position in the laboratory of excellence, labex Plas@Par

Title of the postdoc project: Non thermal plasma for medical applications

Project description:

Context

Over the last ten years application of cold plasma for biomedical purposes has developed from a subdivision of the traditional plasma chemistry into an independent multidisciplinary field. The most important international conferences on plasma physics have now sections and workshops entirely devoted to plasma biomedical applications. Clinical studies have proven that plasma technologies are very promising in biomedical fields; however, due to the very high level of complexity, understanding is still poor concerning mechanisms involved in processes such as cell destruction (necrosis) or cell programmed death (apoptosis) as well as cell proliferation. Many Reactive Oxygen Species such as NO, H2O2, OH-, HOO, O2- etc… are involved in such processes. Furthermore, as the plasma produces also a local electric field, it is likely that there exists a synergistic effect between ROS and the electric field to amplify the cell response.

Feasibility studies since 2011 at LPP in collaboration with Hopital St Louis and IGR

In the frame of the thesis of Ilya Marinov (2010-2013) [1], preliminary studies have been conducted both on preclinical aspects and on fundamentals of cell response: i)

At Hopital St Louis, in the group of Prof. Anne Janin tests have been carried out in vitro on two cell lines (HMEC, Jurkat) and in vivo on nude mice. Influence of plasma was characterized by induction of cell death in the colonies or in the tissues. Dermatological essays have been performed and have proven to be very promising [2].

In parallel, at IGR, in the group of Dr Corinne Dupuy, systematic measurements of plasma produced ROS in the culture medium have been done together with control of cell viability.

Research Program

1. Plasmas sources

Two types of gas discharges, the most often used for cell treatment are dielectric barrier discharge (DBD) or plasma jet discharge. The physical reason of selecting these discharges for in-situ cell or tissue treatment is clear: discharge used for biomedical applications must be simple in use, operate easily at atmospheric pressure conditions, provide the distributed energy release with a negligible heating of the gas. In DBDs for biological applications, one of the electrodes is replaced by living tissue or by a cell culture. Jet discharge at atmospheric pressure is a “synthetic” gas discharge, in the sense that inert gas (as a rule, argon) flowing through the capillary tube, serves as an artificial media for the discharge development. As a result, stable plasma plume of a certain length, from a few mm up to a few cm, is produced at the output of the capillary giving a very convenient use for dermatological applications.

2. Leaving tissues treatment and cell response

Our strategy will be to correlate the response living tissues or cells with plasma produced parameters such as ROS, RNS, E field. Comparison with alternative treatment protocols such as radiotherapy and chemotherapy will be made.

In collaboration with the Group of Corinne Dupuy, Institut Gustave Roussy, we will identify the key ROS generated by the plasma and responsible from the cell response.

From our preliminary studies and study published in the literature dealing with radiotherapy, we will pay a special attention to H2O2; this latter, reactive itself, is known to be a good promoter of highly reactive oxygen species such as OH-.
In addition a collaboration is presently starting with the group of Lori Bridal, Laboratoire d'Imagerie Biomédicale, to investigate microvascular changes produced during NTP therapy with noninvasive, contrast-enhanced ultrasound (US) for both low- and high-dose exposures. Results will provide a new, noninvasive approach to monitor modifications of tumor microvascularization produced by NTP throughout the course of therapy and insight concerning potential to modulate these effects by variation of the NTP dose.

References

[1] *Plasmas in contact with liquids and at the interfaces. Application for living cell treatment*, Ilya Marinov, PhD Thesis, 2013
[2] *Cell death induced on cell cultures and nude mouse skin by non-thermal, nanosecond-pulsed generated plasma*, Duval Arnaud, Marinov Ilya, Bousquet Guilhem, Gapihan Guillaume, Starikovskaia Svetlana M., Rousseau Antoine, Janin Anne
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Requirements for the candidate:

Location and starting date : Laboratoire de Physique des Plasmas, in Palaiseau and in Paris 6; Oct. 2014

Applications with CV, copies of degree diplomas and grades, two reference letters, and copies of any previous research-related work statement of motivation.
Application deadline is May 31st 2014.
The application should be sent preferably by e-mail to:
Antoine.rousseau@lpp.polytechnique.fr