White Paper for *Frontiers of Plasma Science Panel*

Date of Submission:	***07-24-2015***

Indicate the primary area this white paper addresses by placing "P" in right column.
Indicate secondary area or areas by placing "S" in right column

	"P", "S"
• Plasma Atomic physics and the interface with chemistry and biology	P
• Turbulence and transport	
• Interactions of plasmas and waves	
•Plasma self-organization	
•Statistical mechanics of plasmas	

Indicate type of presentation desired at Town Hall Meeting.

	"X"
Oral	
Poster	
Either Oral or Poster	
Will not attend	X

Title:	Plasma-surface interaction – non-thermal plasma in contact with condensed matter
Corresponding Author:	Juergen Meichsner
•Institution:	University of Greifswald, Institute of Physics, Low-temperature Plasma Physics
•email:	meichsner@physik.uni-greifswald.de
Co-Authors:	

- ***Describe the research frontier*** **and importance of the scientific challenge.**

It can be stated, that the research in non-thermal plasma physics and chemistry has been developed more and more in the field of plasma applications and technologies over the last decades. Nevertheless, important open questions in specific fields of the non-thermal plasma physics exist which are mostly combined with other fields of physics, e.g., surface and condensed matter physics, or other sciences such as chemistry (non-equilibrium and heterogeneous chemical reactions at low and atmospheric pressure) as well as nano and material science (functional surfaces and composite films), e.g., for sensors and chemical micro reactors, and life sciences (e.g. plasmas in medicine). Furthermore, increasing activities in development of new space propulsion systems, e.g., plasma thruster, represent another important field in non-thermal plasma physics at low pressure.
The scientific challenge concerns the knowledge about plasma-surface interactions and, in particular, the interface plasma-condensed matter on the atomic scale, [1, 2, 3, 4].

- ***Describe the approach to advancing the frontier and indicate if new research tools or capabilities are required.***

Plasma-surface interaction: plasma physics meets condensed matter physics

- Non-thermal plasmas in contact with solid or liquid surfaces.
- Physics of the interface plasma-solid on the atomic scale, physical and chemical modification of the interface, secondary species emission [5], heterogeneous surface reactions, heterogeneous catalysis.
- New materials for electrodes or dielectric barriers (e.g. ion conducting material).
- Microplasmas with high electron density in contact with solids ("coupling" plasma electrons to electrons in the solid)
- Modeling and simulation of plasma and surface processes (hybrid modeling, 2d-, 3d-modeling).

Non-thermal atmospheric pressure plasmas (barrier discharges, plasma jets)

- Development and application of innovative plasma diagnostic tools [6] with sub-mm and sub-ns resolution, e.g., laser based diagnostics [7], fast optical emission spectroscopy.
- Analysis of discharge/plasma parameters, e.g., local electric filed strength, density and energy distribution function of plasma particles.
- Analysis of plasma chemical reactions at atmospheric pressure (surface, volume),
- In situ analysis of surface processes, e.g., surface charge [7] and charge transport in/on dielectric, secondary particle emission.
- Influence of negative ions, metastables and surface charges on the discharge development, electric breakdown, discharge mode, discharge pattern formation (self-organisation).

- ***Describe the impact of this research on plasma science and related disciplines and any potential for societal benefit***.

Non-thermal plasma technology in general

- Design and construction of new plasma systems/devices and power supplies to control independently the particle energy distribution functions and particle densities by plasma processing parameter
- In situ and real time plasma process diagnostics.

Nanoparticles for functional surfaces and/or composite films

- Formation and/or modification of nanoparticles by reactive plasmas, physical/chemical Sputtering, [8], or conventional top-down technology.
- Technologies for fabrication of functional surfaces and thin films containing nanoparticles with custom-made physical and chemical properties, e.g. chemical micro-reactors, surfaces with catalytic, [9], and/or anti-microbial properties.

Plasmas in medicine/biology

- Application of cold plasmas for treatment of soft matter and surface cleaning/sterilization.
- Innovative coatings of implant materials in orthopedics (cell adhesive/anti-adhesive, anti-microbial properties), [10, 11].

Plasma for space propulsion

- Development and realization of new concepts for plasma thrusters, e.g., plasma thruster based on ion-ion-plasmas.

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