Ruhr University Bochum
Institute for Electrical Engineering
and Plasma Technology
Prof. Dr.-Ing. Peter Awakowicz
Universitätstaße 150 Tel: 0234/32-23062
44801 Bochum Web: www.aept.rub.de

Investigation of filamentary plasma and exploring it for various applications

Nikita Bibinov and Ramasamy Pothiraja
nikita.bibinov@rub.de and pothiraja@aept.rub.de

First phase: Plasma coating of tubes and capillaries for biomedical applications

First phase of DFG Research Group (FOR 1123 "Physics of Microplasmas") project was carried out in the period of April 2009 – March 2012. In this period, a new atmospheric pressure filamentary plasma source was successfully constructed with the intension to be used for film coating on the inner surface of tubes (Fig. 1). This new plasma source was characterized using Optical Emission Spectroscopy and Numerical Simulation with the aid of measured V-I and micro-photographic image of plasma. By this way, plasma parameters during initial segment of discharge at different voltage polarity were determined.[1]

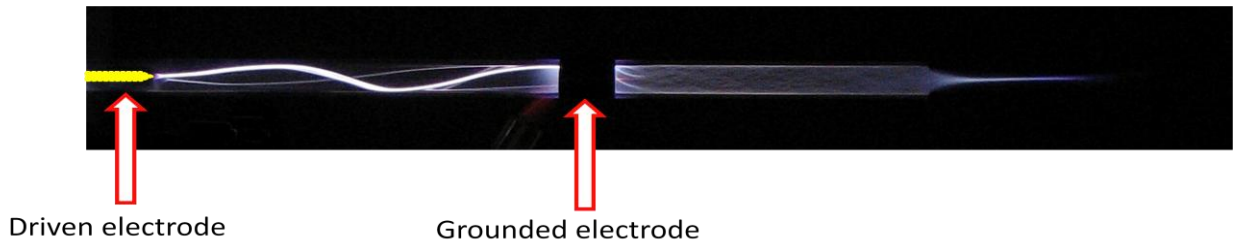

Fig. 1. Filamentary plasma ignited inside a tube.

Following the plasma diagnostics, new plasma source was used for bio-compatible amorphous carbon film coatings on the inner surface of tubes.[2] Films are analyzed and their properties are interpreted on the basis of applied plasma conditions (electron density, reduced electric field),

precursors elemental composition, precursor dissociation mechanism, plasma-solid inter-phase reactions, etc. For this purpose, plasma chemical kinetics are simulated using experimentally determined plasma parameters for various precursors.[3] At the end of first phase of this project, we established a new plasma technology for bio-compatible a-C:H film coatings on the inner surface of tubes including plastic tubes and quartz tubes (Fig. 2).

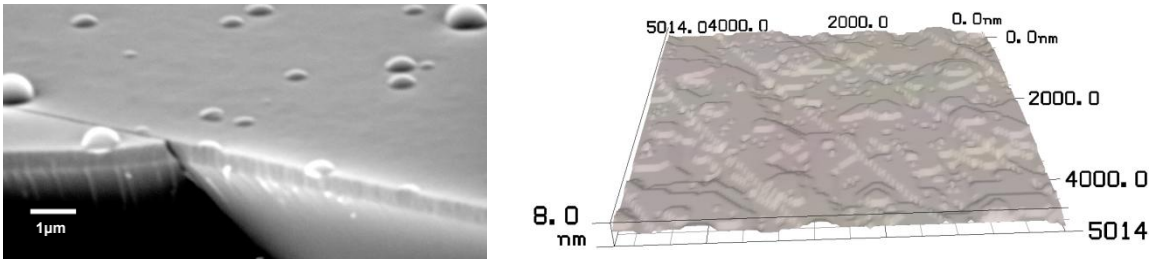

Fig. 2. SEM (left) LSM (right) images of film coated on the inner surface of a tube.

Second phase: Investigation of atmospheric pressure filamentary discharges and its application for film deposition on inner surface of tubes, cavities and flat surfaces

After peer evaluation of first phase of this project, it is extended for three more years. In this second phase, it was planned to extend atmospheric pressure film coating technology from coating on the inner surface of tubes to coating on flat surface as well on the inner surface of cavities. As part of this project, our OES method is developed for time and space resolved plasma diagnostic (Fig. 3),[4,5] and plasma parameters obtained using OES were compared with TALIF and absorption spectroscopy.[6,7]

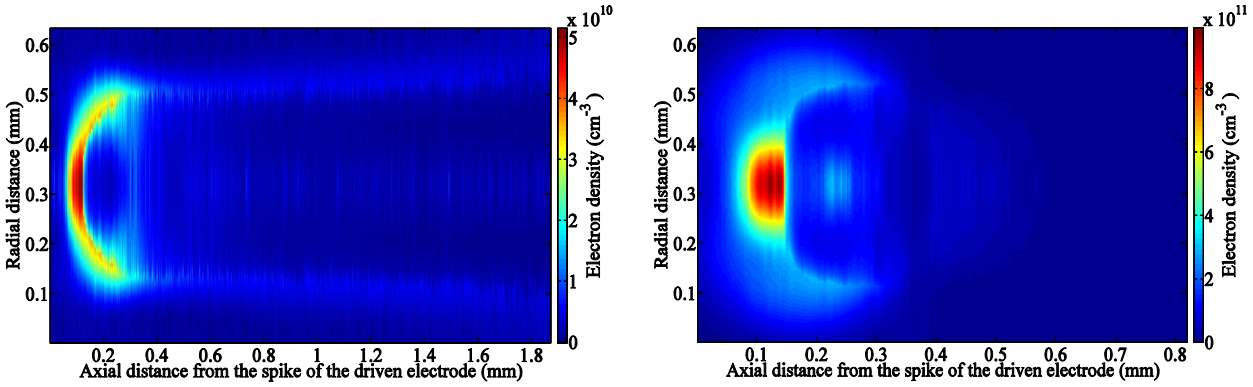

Fig. 3. Spatial distribution of electron density during positive polarity (left) and negative polarity (right) of applied AC voltage in He-N_2 plasma.

Surprisingly, when filamentary plasma is applied inside a cavity, micro-crystals of deposited (Fig. 4).[8] Mechanism of materials transport into the cavity, mechanism of crystal formation and nature of micro-crystals are under investigation.

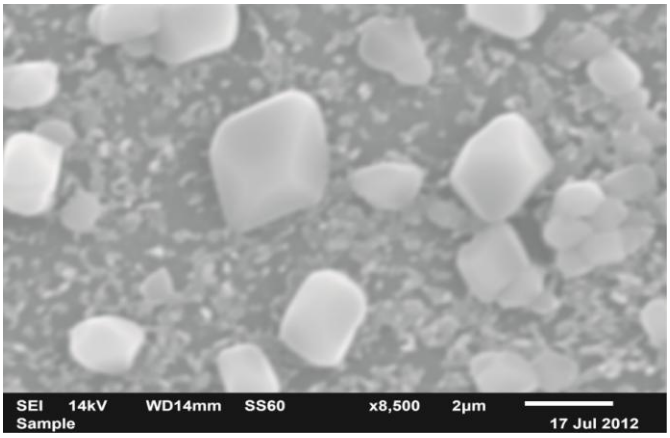

Fig. 4. Micro-crystals deposited inside a cavity by using filamentary plasma in Ar-CH_4 mixture.

References:

1. Pothiraja R, Bibinov N and Awakowicz P 2010 *J. Phys. D: Appl. Phys.* **43** 495201
2. Pothiraja R, Bibinov N and Awakowicz P 2011 *J. Phys. D: Appl. Phys.* **44** 355206
3. Pothiraja R, Bibinov N, Engelhardt M and Awakowicz P 2012 *J. Phys. D: Appl. Phys.* **45** 335202
4. Pothiraja R, Ruhrmann C, Engelhardt M, Bibinov N and Awakowicz P 2013 *J. Phys. D: Appl. Phys.* **46** 464012
5. Rajasekaran P, Ruhrmann C, Bibinov N and Awakowicz P 2011 *J. Phys. D: Appl. Phys.* **44** 485205
6. Bibinov N, Knake N, Bahre H, Awakowicz P, Schulz-von der Gathen V 2011 *J. Phys. D: Appl. Phys*. **44** 345204
7. Schröder S, Pothiraja R, Bibinov N, Awakowicz P, Böke M, Niermann B and Winter J 2013 *J. Phys. D: Appl. Phys*. **46** 464009
8. Pothiraja R, Bibinov N an d Awakowicz P 2014 *J. Phys. D: Appl. Phys.* **47** 315203