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Сборник содержит материалы, представленные в виде устных докладов на 5й международной летней научной школе по физике взаимодействия плазмы с поверхностью.

The book of abstracts contains materials presented in the form of oral presentations at the 5th international summer scientific school on physics of plasma-surface interaction.

Национальный исследовательский ядерный университет «МИФИ»
115409, Москва, Каширское ш., 31

July, 5 (Chair: A.A. Pisarev) – Monday

10:00	Yu. Gasparyan. Opening
10:30–11:30	G. Van Oost. “ITER and beyond”; Structural Materials for Fusion Devices
11:40–12:40	E. Marenkov. Vapor shielding of liquid metal plasma facing components
13:00–14:00	**Lunch**
14:00–15:00	A. Pisarev. Uncertainties in estimations of tritium accumulation in ITER divertor plates due to plasma implantation: Influence of basic parameters
15:10	Students’ talks Chair: E.D. Marenkov

July, 6 (Chair: A.S. Kukushkin) – Tuesday

10:00–11:00	T. Tanabe. Perspective of Plasma-Material Interactions in a fusion reactor
11:10–12:10	T. Tanabe. Perspective of Plasma-Material Interactions in a fusion reactor (contd.)
12:20–14:00	**Lunch**
14:00–15:00	K. Nordlund. Molecular dynamics method for radiation damage calculations
15:00–16:10	F. Djurabekova. Binary collision approximation and kinetic Monte Carlo method for radiation damage calculations
16:30	Students’ talks **Chair: L.B. Begrambekov**

July, 7 (Chair: Yu. M. Gasparyan) – Wednesday

10:00–11:00	C. Grisolia. Dust and its impact on tokamak safety
11:10–12:00	A. Litnovsky. Advanced materials for a future fusion plant
12:20–14:00	**Lunch**
14:00–15:30	A. Kukushkin. 2D fluid modeling of divertor plasma. Basics and trend
15:10	Students’ talks **Chair: A.A. Pisarev**

July, 8 (Chair: L.B. Begrambekov) – **Thursday**

10:00–11:30	R. Pitts. ITER project status
11:40–13:10	R. Pitts. ITER divertor physics basis
13:20–15:00	**Lunch**
15:00	Students' talks **Chair: Yu. M. Gasparyan**

July, 9 (Chair: A.A. Stepanenko) – Friday

10:00–11:00	L. Begrambekov. Sputtering and modification of materials under ion-plasma irradiation at temperatures of "active diffusion"
11:10–12:10	J. Horacek. Scrape of layer turbulence transport
12:20–13:20	D. Heim, T. Mueller. Glow discharge plasma in industrial applications
13:25–14:00	Discussion. Closing

STUDENTS' TALKS

July, 5

15:10–15:30	V. Kulagin. Study of helium-induced structures on tungsten plasma-facing components.
15:30–15:50	A. Alieva. The status of the MEPHIST tokamak development
15:50–16:10	K. Ashurova. Research of the melt life time influence on the structure and properties of hypereutectic silumin.
16:10–16:30	N.S. Sergeev. Compact ICP Device For Laser Induced Breakdown Spectroscopy
16:30–16:50	N.A. Puntakov. Removal of carbon atoms from the near-surface layers of graphite by high intensity deuterium ion flux at high temperatures

July, 6

16:30–16:50	Nandini Yadava. Behavior of hydrogen and impurities in ADITYA-U tokamak plasmas after lithium coating.
16:50–17:10	E. Fox-Widdows. Correlation of hydrogen emission and electron properties in low temperature plasma conditions close to divertor-like materials.
17:10–17:30	N. Trklja Boca. Effects of high thermal loads produces by interaction of accelerated plasma with materials.

July, 7

15:10–15:30	C. Cowley. Optimizing detachment control using the magnetic configuration of divertors
15:30–15:50	G. F. Nallo. SOLPS-ITER simulations for an EU DEMO with a liquid metal divertor and Argon seeding
15:50–16:10	K. Shah. Estimation of Argon and Neon influxes and transport in Aditya-U plasma
16:10-16:30	M. Keisuke. Absolute calibration method for hydrogen permeation probe using emission spectroscopy

16:30 – 16:50	S.S. Dovganyuk. Formation of surface layers during plasma deposition of aluminum atoms on tungsten and their trans-formation during radiation heating

July, 8

15:00–15:20	Tran Quang V. Development of a stationary RF-heating system of helicon type for PLM-2 plasma device
15:20–15:40	K. Soni. Experimental and numerical characterization of an RF plasma in DC grounded electrode configuration using a $\lambda/4$ filter
15:40–15:00	I. Oshenko. Electrophysical parameters of AC plasma systems
16:00-16:20	O. Kamboj. Study of stimulated Raman forward scattering in presence of azimuthal magnetic field in a density rippled plasma in inertial confinement fusion
16:20 – 16:40	A.A. Stepanenko. Reflection of electromagnetic waves and propagation of sheath-connected filaments at the edge of fusion devices

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STUDY OF HELIUM-INDUCED STRUCTURES ON TUNGSTEN PLASMA-FACING COMPONENTS

The choice of materials for plasma-facing components (PFC) is a crucial factor for the sustained operation of future fusion devices. Up to date, tungsten (W) is the main material for the ITER divertor region [1]. The morphology of tungsten PFC can change under helium plasma impact resulting in the formation of nano-tendrils. The irradiation of hot tungsten surface by helium ions leads to the formation of tungsten fuzz [2], whereas inclusion of gas impurity (e.g., Ne, Ar) into helium ion flux might result in the appearance of nano-tendril bundles (NTBs) [3]. Physical properties of such helium-induced morphologies radically differ from the smooth tungsten surface. The main negative change in properties is an increased probability of PFC erosion [4].

Although the helium-induced morphology has been studied for years, a certain growth mechanism has not been clarified yet. The determined growth mechanism will help to estimate the probability of PFC modification during helium ion bombardment in future fusion devices. This work is focused on the experimental verification of the most promising theory based on the diffusion of W-adatoms [5, 6]. The chosen theory can explain the appearance of both types of structures. Experimental tests aimed to recreate the rate of W-adatom formation on a hot fuzzy surface, excluding the influence from the helium ion irradiation. The gas-change during the fuzz formation and W-deposition on hot fuzzy surface were performed for the theory verification.

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THE STATUS OF THE MEPHIST TOKAMAK DEVELOPMENT

Nowadays small spherical tokamaks play a huge role as research tools, and as powerful educational devices for fusion students. The MEPhIST (MEPhI Spherical Tokamak) tokamak is a small spherical tokamak with a major radius R = 25 cm, minor radius a = 13 cm [1]. The device is being under development at the Plasma Physics Department, Institute of Laser and Plasma technologies (LaPlas), NRNU MEPhI.

Main aims of the MEPhIST tokamak are not only the education of students, but also research and development. For example, lithium technologies development, studies of plasma confinement, plasma-wall interactions, electron-cyclotron resonance (ECR) assisted breakdown, ion-cyclotron resonance (ICR) plasma heating are important features.

The study discusses the present status of the MEPhIST development, obtained result, and future plans. An improvement of breakdown conditions was considered using a design of experiments technique. Then, the argon gas discharge was achieved, and the overview spectrum was obtained using passive spectroscopy methods. Additionally, the fast CCD-camera shot the evolution of the discharge. Furthermore, we consider the future diagnostics, ICR heating system and device modification plans [2].

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RESEARCH OF THE MELT LIFE TIME INFLUENCE ON THE STRUCTURE AND PROPERTIES OF HYPEREUTECTIC SILUMIN

The purpose of this work was to demonstrate the possibility of controlling the surface temperature of AlSi18 alloy (silumin) during pulsed electron beam irradiation.

Irradiation of the surface of the specimen surface was carried out with an electronic source with grid plasma cathode based on low-pressure arc discharge, which allows controlling main parameters of electron beam independently of each other. The following irradiation modes were selected: a quasi-rectangular beam current pulse at an amplitude of 80 A and a duration of 200 µs at an accelerating voltage of 15 keV with an energy density of 20 J/cm^2; the same rectangular pulse with the further holding the temperature at the level of 1293 K for 400 µs; a rectangular pulse with the temperature holding at 893 K for 800 µs.

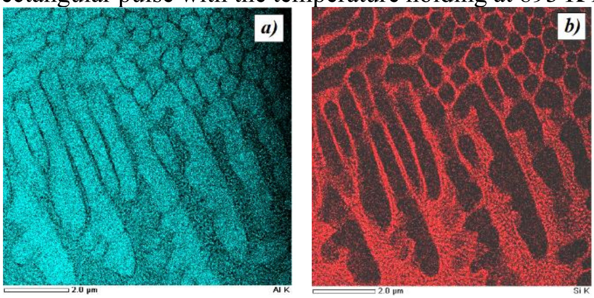

Fig.1. Silumin structure after irradiation with a pulsed electron beam (20 J/cm2, 200 µs, the temperature was kept at 873 K for 800 µs); the images were obtained in characteristic X-ray radiation of (a) aluminum and (b) silicon atoms.

Analysis of the strength and tribological properties of the surface layer of silumin shown that the hardness of the sample irradiated in the regime of 20 J/cm^2, 200 µs and with the temperature holding at 873 K for 800 µs exceeds the microhardness of the initial sample by 2.2 times, and the wear rate decreased by 3.7 times.

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COMPACT ICP DEVICE FOR LASER INDUCED BREAKDOWN SPECTROSCOPY

Accumulation of the hydrogen isotopes in plasma-facing materials remains one of the crucial problems in modern fusion-oriented studies [1]. Development of new in situ measurement methods for determination of the hydrogen isotopes content in components of the first wall is one of the key tasks of ITER project [2].

In this work, we present a new concept of compact inductively coupled plasma (ICP) based device for in situ investigation of the hydrogen isotopes retention in the plasma-facing materials of tokamaks. In this concept, plasma created by a radiofrequency planar coil allows to significantly increase life of the plasma, created by laser ablation process. Additionally, such type of installation allows to create a spatial uniform plasma area with flat plasma parameters profiles that ensures optimal conditions for created as well as laser induced plasmas.

For spectroscopy measurements the change of the spectral lines ratio of the H impurity radiation and He/Ar plasma emission spectrum of the ICP discharge is planned to be studied in the future. The measurements of Balmer series lines intensities ($n' = 2$ и $n = 3, 4, 5$) are considered. The measurements are going to be carried out with different fractions of impurity in the working gas.

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REMOVAL OF CARBON ATOMS FROM THE NEAR-SURFACE LAYERS OF GRAPHITE BY HIGH INTENSITY DEUTERIUM ION FLUX AT HIGH TEMPERATURES

In this work, experiments on the irradiation of R6510P100D01 grade graphite [1] to be used as a first wall material in the T-15MD tokamak [2] irradiated by a high intensity deuterium ion flux were conducted on the CODMATT stand [3]. The ion energy was 14 keV/ion, flux density was 1.4×10^{18} ion/cm^{2}s, and the irradiated surface temperature range was between 750 and 2050°C. Dependence of graphite erosion on temperature and dose of irradiation was investigated.

It was found that sputtering of graphite by deuterium ions with the flux density of 1.4×10^{18} ion/cm^{2}s leads to formation of a porous layer in the near-surface area of the graphite sample. The width of that layer grew with the increase of both temperature and dose of irradiation. For 2050°C, the maximum width of the porous layer reached at least 1.5 mm, which exceeded the average penetration depth of deuterium ions in graphite by a few orders of magnitude [4]. This occurred due to the transport of vacancies from the impact layer of graphite into the depth and, correspondingly, diffusion of carbon atoms to the surface. After a certain dose of irradiation, unique for each temperature, was reached, equilibrium between the sputtering of the surface and a diffusion of carbon atoms from the depth of the sample was established, and the growth of the width of the porous layer stopped. It was also established that the increase of temperature from 750 to 2050°C not only led to the increase of the width of a porous layer in the sample, but also increased the irradiation dose necessary for the sputtering and the diffusion to establish an equilibrium state.

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BEHAVIOR OF HYDROGEN AND IMPURITES IN ADITYA-U TOKAMAK PLASMAS AFTER LITHIUM COATING

The interaction of plasma with plasma facing components (PFC) plays important role to modify the edge plasma properties via introducing recycled fuel particle and impurities, like carbon and oxygen. These particles alter the edge plasma dynamic leading to modification of the core plasma properties. In ADITYA-U tokamak, behavior of hydrogen and impurities has been studied for the discharges produced after routine hydrogen Glow Discharge Cleaning of vessel and also after lithium coating. ADITYA-U has two poloidal ring limiters at outboard side and one toroidal belt limiter on the inboard side of the vessel. The limiter surfaces are of the graphite material and vessel wall surfaces are made of stainless steel. Many PMT based visible spectroscopy optical set up have been installed on the tokamak along various lines of sight terminating on various surfaces for monitoring the radiation during plasma operation to plasma to understand their relative importance in introduction of particles inside the plasma. The investigation has been done by estimating influxes and the concentrations of hydrogen and carbon and oxygen at plasma edge for the plasmas before and after Li coating and then correlating those with core plasma parameters. The recycling coefficient, R, is also measured to quantify particle recycling with lithium wall conditioning. In this presentation, these results would be discussed in details.

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CORRELATION OF HYDROGEN EMISSION AND ELECTRON PROPERTIES IN LOW TEMPERATURE PLASMA CONDITIONS CLOSE TO DIVERTOR-LIKE MATERIALS

Understanding the behaviour of atoms and molecules in tokamak divertor plasmas is vital in order to understand the key processes that result in divertor detachment, crucial for the successful operation of future fusion devices [1].

The aim of this research is to understand atomic and molecular emission of hydrogen in a controlled low-temperature plasma environment close to divertor-like materials. The study combines electron property measurements, using Langmuir probes, with plasma emission measurements, in an Inductively Coupled Plasma (ICP) discharge source. A sample heater was used to insert Carbon and Tungsten surfaces into the plasma, which allowed the material temperature and surface conditions to be varied, while the discharge ICP environment allows the plasma conditions to be varied in a controlled way.

For these experiments, the pressure and power were varied from 0 to 10 Pa and 10 to 300 W respectively, to provide a variety of electron properties, with densities of 10^{16}-10^{18} m^{-3}, and electron temperatures of 1-6 eV. Emission intensities were measured over a range of wavelengths, focusing on atomic emission of the Hydrogen Balmer lines and molecular emission in the Fulcher band. The temperature of the carbon or tungsten surfaces was varied from 100-1200C. The experimental data was used to correlate hydrogen emission with plasma and surface conditions. These results will be compared with results from a 0-D collisional radiative model, and also used to inform emission measurements planned for the current MAST-U campaign in the Super-X divertor [2].

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EFFECTS OF HIGH THERMAL LOADS PRODUCES BY INTERACTION OF ACCELERATED PLASMA WITH MATERIALS

Magnetoplasma compressor (MPC) is accelerator of a dense fully ionized plasma with operation based on the common theory of a dense plasma flow and acceleration developed by Morozov [1]. The capacitor battery is charged to the operating voltage 4 kV from a DC source and total amount of energy stored in the capacitor bank is 6.4 kJ. Capacitor bank is discharged through the MPC electrode system positioned in the vacuum chamber filled with gas and compressed plasma flow is formed ($N_e \sim 10^{22}$ m^{-3}, $T_e \sim 1$ eV, v ~ 100 km/h, duration of the plasma pulse is around 150 μs).

Energy and energy flux density distribution along the axis of discharge have been measured for different working gases: hydrogen, helium with 5% of hydrogen and argon. Results of calorimetric measurements are used for determination of the optimal position and type of the gas for investigation of the plasma-material interaction [2].

Morphological changes occurring on aluminum-titanium and nickel-titanium thin films, deposited on the silicon substrate, when treated with a compressed plasma flow have been investigated by atomic force microscope (AFM) and scanning electron microscope (SEM).

MPC is also used for treatment and alloying of steel samples: steel 100Cr6, steel 16MnCr5 and steel 42CrMo4. Changes in the physical composition of the substrate are monitored depending on the number of plasma treatments by optical microscopy, measurement of hardness and roughness and x-ray diagnostics. Spectroscopic measurements enabled detailed plasma diagnostics. After treatment with a plasma produced within MPC, a significant improvement of hardness has been achieved [3].

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OPTIMIZING DETACHMENT CONTROL USING THE MAGNETIC CONFIGURATION OF DIVERTORS

As magnetic confinement fusion devices move to higher power, reactor-like machines, the control of an optimally detached divertor plasma has become increasingly relevant. Detachment is typically accessed through detachment control parameters, such as upstream density, impurity concentration, or power into the upstream separatrix. Upon detachment, a change in these control parameters can push a detachment front towards the upstream of back towards the target. The sensitivity of this movement with respect to control parameter change depends strongly on the magnetic configuration of the divertor. Through analytical models and simulation, this relationship is analysed, to better understand the magnetic features experimentalists may use to achieve optimal evolution of detachment.

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SOLPS-ITER SIMULATIONS FOR AN EU DEMO WITH A LIQUID METAL DIVERTOR AND ARGON SEEDING[1]

Self-healing liquid metal (LM) divertors using a capillary-porous structure are considered among the alternative solutions to the power exhaust problem in fusion reactors [1,2]. Capillary forces can indeed prevent LM droplet ejection and compensate for LM evaporation and sputtering. On the other hand, the latter phenomena can lead to core plasma dilution (for low-Z metals, such as Li) or radiation (for high-Z metals, such as Sn) [3]. Modelling the eroded metal transport and its interactions with the plasma in the SOL and core is essential to assess the compatibility of an LMD with plasma operational requirements for a fusion reactor such as the EU DEMO.

We used the SOLPS-ITER code with fluid neutrals to study the EU DEMO SOL plasma behavior in the presence of an LMD. Metal emission from the target was evaluated self-consistently with the plasma fluxes, thus allowing to compare Li vs. Sn. Our simulations indicate that, if Ar seeding is adopted, a promising operational window exists where an LM divertor can operate without excessive evaporation, and therefore with limited plasma contamination.

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ESTIMATION OF ARGON AND NEON INFLUXES AND TRANSPORT IN ADITYA-U PLASMA

The spectroscopic studies of neon and argon impurities have gathered renewed interest for the controlled nuclear fusion plasmas due to the fact that in case of ITER discharges, seeding of neon and argon impurities seem to be mandatory to reduce the heat load on tungsten divertor plates [1]. These externally injected impurities directly influence various plasma parameters and overall plasma behavior. Hence understanding a detailed picture of impurity influxes and transport is required for optimum performance of the fusion plasma.

In case of Aditya-U tokamak, spatially resolved Ar II line emissions have been observed using a high resolution 1m Czerny Turner configuration spectrometer together with a charge coupled device (CCD) detector [2]. Moreover, a survey spectrum of argon and neon line emissions in the visible range has been recorded using 0.5 m spectrometer- CCD system. For the estimation of influx of argon and neon into the tokamak, appropriate spectral lines were identified to obtain ionization per photon coefficients (S/XB) data from ADAS database. The influx of neon and argon were estimated and their edge concentrations were studied with core plasma properties. Moreover, from the profile measurements, argon transport through the estimation of the diffusion coefficient has been investigated by comparing the radial profile of Ar II emission obtained by inverting the line-integrated Ar II data, with those simulated using 1D impurity transport code. A complete detail of edge impurity behavior and transport will be discussed in the paper.

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ABSOLUTE CALIBRATION METHOD FOR HYDROGEN PERMEATION PROBE USING EMISSION SPECTROSCOPY.

To improve the understanding of hydrogen recycling, especially in long duration discharges, one needs to know the atomic hydrogen flux to plasma facing materials [1]. A permeation probe based on PdCu membrane is used in QUEST tokamak to determine such a flux [2, 3]. It is known that the permeation through a PdCu membrane is in surface limited regime, where the condition of the interface is of utmost importance. The incident atomic hydrogen flux is estimated from the permeated flux using recombination coefficients, measured in a separate apparatus with nuclear reaction analysis [4]. Such approach is useful for qualitative analysis, but a proper in-situ calibration method is required to perform a quantitative analysis.

In the present work we describe a new calibration method for a permeation probe based on a visible emission spectroscopy. First, we achieve a steady-state permeation with hydrogen plasma on the upstream of the PdCu membrane, kept at 300 ºC, and calculate the permeation flux from a calibrated mass-spectrometer signal. Next, we use the intensity of the hydrogen Balmer γ emission line to calculate the ground state population of hydrogen atoms in the upstream chamber using collisional-radiative model. From the calculated atomic hydrogen density an incident flux is calculated. Finally, the unknown recombination coefficient for the upstream side of the membrane is determined, $k_u = (2.9 \pm 1.5) \times 10^{-28}$ m^4 s^{-1}.

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FORMATION OF SURFACE LAYERS DURING PLASMA DEPOSITION OF ALUMINUM ATOMS ON TUNGSTEN AND THEIR TRANSFORMATION DURING RADIATION HEATING

The aim of the International Thermonuclear Experimental Reactor (ITER) project is to experimentally demonstrate the possibility of obtaining a safe and inexhaustible source of energy based on the fusion of deuterium (D) and tritium (T) [1]. Tritium is a radioactive element; to ensure safety, its maximum content in the installation is limited to 700 g. [2]. One of the possible ways to accumulate tritium is for it to be trapped in plasma facing components (PFC's). Beryllium (Be) and tungsten (W) were chosen as the PFC materials of ITER [3]. During the operation of the reactor, Be atoms will be redeposited onto W, which can lead to the formation of intermetallic alloys of Be and W [4-7].

In our previous work [8], it was shown that during deposition of Be on W, thermal desorption of hydrogen from high-temperature (1200-1400K) traps was observed, which was not characteristic of either Be (980K) or W (900K). A similar feature was revealed in the case of deposition of aluminum (Al, Beryllium safety surrogate material) on W. It was shown that such high-temperature thermal desorption can be associated with the formation of W-Al and W-Be compounds.

This paper presents the results of an SEM study of the cross-section of a sample with surface W-Al layers formed at various doses of deposition of Al atoms. The effect of heating the sample on transformation of such surface layers is shown.

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DEVELOPMENT OF A STATIONARY RF-HEATING SYSTEM OF HELICON TYPE FOR PLM-2 PLASMA DEVICE

The PLM-2 [1] linear magnetic plasma device is for steady-state stationary hours-long plasma confinement with parameters providing the relevant fusion reactor plasma loads on materials. The machine is designed both for fundamental studies of plasma-surface interactions under high heat and particle fluxes, and as a high-heat flux facility for the tests of plasma-facing components under realistic plasma conditions.

For the PLM-2 plasma device, a stationary RF-heating system was developed using a helicon antenna. Production of plasma by using helicon waves is known as helicon discharge, and the plasma produced by using the helicon discharge has a totally distinct character where the enhancement of the plasma parameters takes place at particular conditions. Helicon discharges produce higher density plasma (up to $\sim 10^{19}$ m^{-3}) at a comparatively lower given input power than any other RF or DC discharges [2], and also the plasma is least contaminated due to the presence of the antenna out-side the chamber.

The RF-heating system consists of helicon antenna, RF power source, matching network, cooling system, and RF shielding and grounding. The design of a helicon antenna was proposed to ensure a stationary mode of operation. The maximum input power is 4 kW and the frequency is 27.12 MHz. The quartz glass is placed inside the antenna to avoid the direct contact between antenna and plasma, to maximize the absorbed power by plasma. A matching system was manufactured, which consists of two vacuum variable capacitors with a nominal capacity of 20 to 1000 pF. This system can provide guaranteed operation over a wide range of load impedances.

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EXPERIMENTAL AND NUMERICAL CHARACTERIZATION OF AN RF PLASMA IN DC GROUNDED ELECTRODE CONFIGURATION USING A λ/4 FILTER

The in-vessel First Mirrors (FMs) will play a vital role in most optical diagnostic systems in ITER. The FMs, being the initial elements in the optical path in the diagnostic systems, will be exposed to high thermal load caused by neutron and gamma irradiation. The FMs would also be subject to erosion and/or deposition of the first wall materials (Be and W) which would severely compromise their optical properties. To cope with the optical degradation, the FMs would undergo an in situ plasma cleaning with Capacitively Coupled Radio Frequency (CCRF) discharges [1].

Most First Mirror Units (FMUs) in ITER diagnostic systems will require active water-cooling in the FMs. To simplify the FMU engineering, a stop-band quarter lambda filter (notch filter) will be formed by the water-cooling pipes with a length of a quarter of the RF wavelength [2]. The notch filter grounds the FMs, and the mirrors no longer acquire a self-bias. However, the presence of notch filter influences the CCRF plasma for the purposes of mirror cleaning. Therefore, an experimental and numerical study was carried out to evaluate the impact of notch filter with different electrodes (insulating and conducting) on the plasma properties, i.e., plasma and floating potential, electron temperature, electron density, ion flux and mean ion energy.

In this study, plasma cleaning experiments were performed in a high vacuum system with 13.56 MHz CCRF plasma by grounding the driven electrode with a notch filter and employing argon as the process gas. The plasma in the bulk and on the wall was characterized using a Langmuir probe and retarding field energy analyser, respectively. The influence of power (in range of 10-20 W) and the resulting driving voltage amplitude, the pressure (in range of 0.5-2 Pa) and the conducting area of the electrode (from 0 to 100 %) on the plasma characteristics was studied. The conducting area was found to highly influence the plasma potential: it remained around 20 V with the 100 % insulating electrode, while it increased to 150 V when using an entirely conducting electrode. Particle-in-cell with Monte Carlo collisions simulations were also performed to determine the plasma properties for the experimental conditions. The results obtained experimentally and via simulations are in good agreement and also display an intermediate plasma potential value for the sample with 50% insulating and 50% conducting surface.

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ELECTROPHYSICAL PARAMETERS OF AC PLASMA SYSTEMS

There is a fairly extensive list of methods for the synthesis of nanoparticles, but one of the most promising is the synthesis of nanometer-sized particles as a result of the interaction of a gas discharge and a liquid. The methods of this group make it possible to obtain particles of a given shape and size. In this study, an attempt was made to determine the main characteristics of plasma-solution systems when using alternating current with a frequency of 50 Hz.

The studied discharge was excited between two electrodes made of different materials, such as molybdenum, copper and iron. The diameters of the electrodes did not exceed 1 mm. The inter electrode distance was lying in the range from 0.5 to 4 mm. The discharge current was in the range from 100 to 400 mA.

In all emission spectra of an alternating current discharge burning in distilled water, emission lines of hydrogen and atomic oxygen, as well as bands of hydroxyl radicals, were recorded. In addition, emission lines of the atoms of the electrode materials were recorded.

From the ratio of the intensities of the OH bands, the effective vibrational temperature and the rotational temperature of $OH(A^2\Sigma)$ were determined. In addition, an estimate of the arc discharge temperature was made, which was 5800 ± 500K.

Some features of the characteristics of the liquid phase of the plasma-solution system were determined, so a nonlinear dependence of the pH and conductivity of the solution on the time of the process was observed.

Also, stable conditions of discharge combustion were found for various electrode materials. So, for example, for a combination of Cu-Cu electrodes, this is a discharge current of 100 mA, an inter electrode distance of 0.88–1.1 mm, and a preliminary generation time of charge carriers - 1 minute.

In addition, the discharge burning voltage was estimated at various inter electrode distances.

The obtained data on the electrophysical parameters of the discharge in a liquid can be used to find the optimal conditions for the synthesis of nanopowders.

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STUDY OF STIMULATED RAMAN FORWARD SCATTERING IN PRESENCE OF AZIMUTHAL MAGNETIC FIELD IN A DENSITY RIPPLED PLASMA IN INERTIAL CONFINEMENT FUSION

This study observes the growth of stimulated Raman scattering in presence of azimuthal magnetic field and a density rippled plasma in inertial confinement fusion. In the presence of an azimuthal magnetic field, the Gaussian laser beam, propagating through a density rippled plasma, is intensified by forward Raman scattering, resulting in two radially localised electromagnetic sideband waves and a lower hybrid wave. In the presence of density rippled plasma, the nonlocal influence induced by the azimuthal magnetic field reduces the nonlocal contact area and, as a result the growth rate, thereby minimizing the possibility of pre-heating of plasma in ICF.

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REFLECTION OF ELECTROMAGNETIC WAVES AND PROPAGATION OF SHEATH-CONNECTED FILAMENTS AT THE EDGE OF FUSION DEVICES

Turbulence plays the key role in setting particle and heat fluxes coming to the plasma facing components in tokamaks and stellarators, thus determining their operational performance. Experimental evidence shows that anomalous transport of edge plasma is connected, among other things, to the motion of blobs [1], which motivated their intensive study over the past two decades [2].

Edge plasma dynamics in future fusion devices is expected to be governed by electromagnetic effects provided the plasma $\beta > m_e/m_i$ [2]. Recently, it was demonstrated that in low-β ($\beta < m_e/m_i$), yet sufficiently hot peripheral plasma of a tokamak electromagnetic regimes of blob propagation can also exist due to the interplay between the collision skin effect and the propagation of Alfvén waves [3]. However, for the analysis of blob dynamics the physical model incorporating electrostatic sheath boundary conditions (modified to take account of the electromagnetic effects) was used. Such a model neglects the reflection of electromagnetic waves from the conducting surfaces of the installation, with which blobs contact during their motion.

In this contribution, we analyze blob dynamics at the edge of fusion devices, by taking into account the reflection of electromagnetic waves from the plasma facing components. The physical model describing plasma dynamics is formulated. Special attention is paid to the discussion of physics of wave reflection and the associated modification of the sheath boundary conditions determining filament dynamics. The estimates of the blob motion parameters are shown. Analytical results are compared with results of numerical modeling of filament dynamics at the edge of a tokamak.

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