Study of the combined glow + microwave discharges and ICWC wall conditioning scenarios in TOMAS & Development of a thermal desorption probe for TOMAS wall conditions characterization

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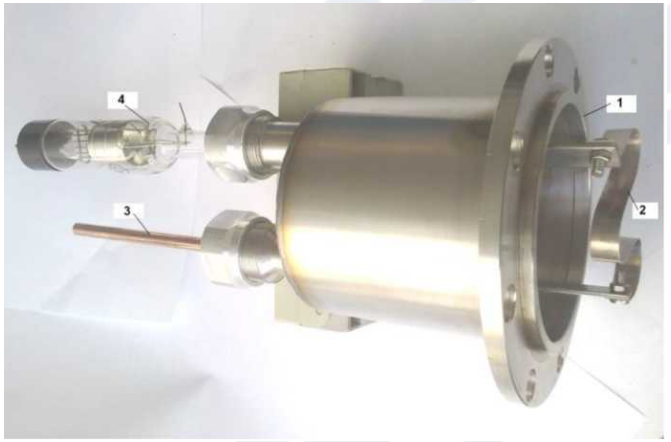
Development of a thermal desorption probe for TOMAS wall conditions characterization

The thermal desorption probe is used to determine the **in situ** outgassing rate of wall materials and to estimate the number of molecular layers of residual gases on their surfaces.

Thermal desorption diagnostics is based on heating material samples in a vacuum chamber and measuring the total and partial pressures.

This diagnostic method was implemented in the Uragan-2M stellarator and was used both before and after the wall conditioning procedure.



The thermal desorption modules with SS probe (#2): 1- flange to connect to the port of the U-2M, 2- thermal desorption zigzag shaped stainless steel probe, 3- copper electrode, 4- ionization gauge.
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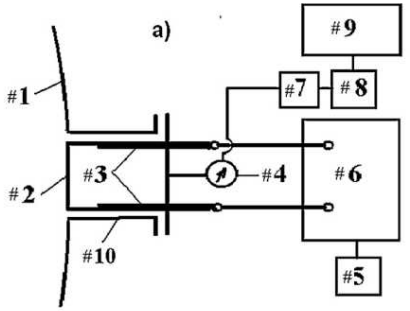

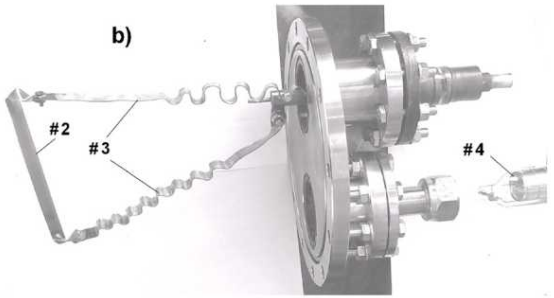

Scheme of the experiment (a) and photo of the thermal desorption probe (b): 1- U-2M vacuum chamber wall, 2- stainless steel probe, 3- current contacts, 4-ionization gauge, 5- time relay, 6-electric power supply, 7- VIT-2 vacuum measurement device, 8- interface module WAD-AIK-BUS, 9 - computer, 10 - branch pipe.

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Development of a thermal desorption probe for TOMAS wall conditions characterization

The main objective is to adapt the thermal desorption probe for the TOMAS and to implement diagnostics based on it as part of the wall conditioning procedure.

To do this, we plan to use the equipment available on TOMAS: vacuum ports, vacuum gauges, and the QMS.

The installation place (flange) for the TDP was preliminarily determined. A prototype of the TDP was made.

Development of a thermal desorption probe for TOMAS wall conditions characterization

1. The TDP design is currently being developed. Stainless steel is expected to be used as the TDP material in the first phase.

2. Calculations are currently being performed to determine the current required to heat TDP plates, taking into account various dimensions. Time required to heat the TDP to temperatures ranging from 100 to 600 ^{0}C.

3. Determining the power supply specifications for TDP. A low-voltage, high-current power source.

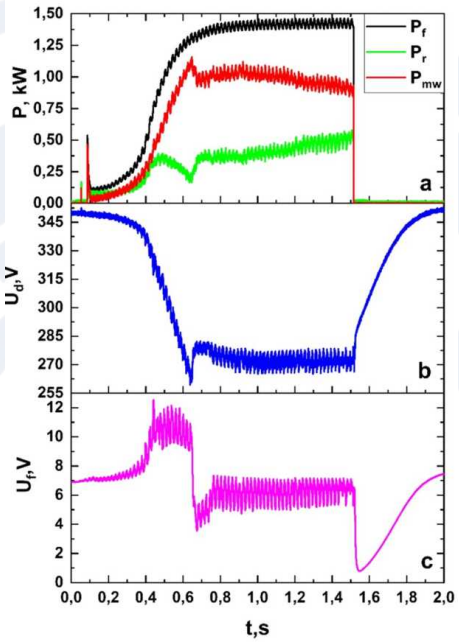
4. Preparation of technical documentation and manufacture of TDP.

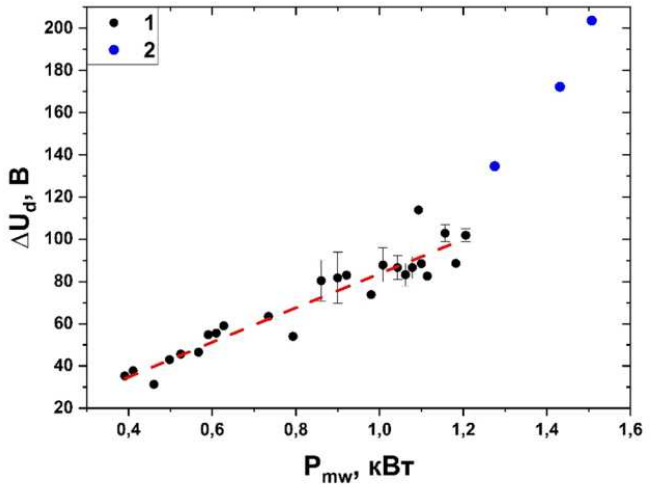
Study of the combined glow + microwave discharges and ICWC wall conditioning scenarios in TOMAS

The GDC process has a drawback: sputtering of structural materials in the vacuum vessel by ions created by the glow discharge plasma. The ion energy in a given discharge depends on the voltage at the discharge. The changes in the discharge voltage are only possible in a certain range of values, to maintain its stable burning.

The first experiments on the realisation of combined glow+ microwave discharge in large volumes for wall conditioning were carried out at DSM-1 and Uragan-2M (**Sci. innov. 2021. 17 (4)**). The experiments carried out showed the possibility of using the combined glow + microwave discharge in large volumes of toroidal vacuum chambers.

The first studies combined glow + microwave discharges at the TOMAS facility have shown that the injection of additional microwave power allows to reduce the voltage on the glow discharge. The maximum observed voltage decreases in the combined glow + microwave discharges compared with a reference glow discharge at ≈ 220 V.





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The analysis of discharge characteristics (volt-ampere characteristics, plasma optical spectrum, ion energy) in argon and helium atmospheres is ongoing.

An analysis is being conducted of the first experiment on wall conditioning using a combined glow + microwave discharges.

New experiments are planned to determine the plasma parameters (density and temperature) in a glow discharge and in a combined glow + microwave discharges. In addition, wall conditioning with combined glow + microwave discharges. Experiments with a combined microwave glow discharge (GD+MW) and glow discharge (GD) on TOMAS in an atmosphere of mixtures of gases Ar+He, H_2+He, Ar+H_2, in different proportions.

Study of the combined glow + microwave discharges and ICWC wall conditioning scenarios in TOMAS

The analysis of the TOMAS experiments on wall conditioning using RF discharge in an argon atmosphere has been completed. A paper based on these results is currently being prepared.

Analysis of data from experiments on wall conditioning using RF discharge in a helium atmosphere is ongoing.

Further experiments are planned on wall conditioning using RF discharge and a combined ECR+RF discharge.