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Abstract

In the framework of the liquid metal research it has been taken into account the use of liquid metals as plasma facing materials in fusion devices. Two different materials have been studied in the Frascati Tokamak Upgrade (FTU): lithium and tin. After the successful experiments with liquid lithium limiter (LLL), started since 2006, a liquid tin limiter (TLL) has been tested on FTU in the experimental campaign, started at the end of 2016. The preliminary analysis of the experimental data has been focalized to detect the presence of tin in the discharge: suitable monitors are the spectroscopic diagnostics in the visible and VUV ranges. The experimental observation of the tin spectral lines represents a new goal for extending the database of atomic nuclear data in the plasma tokamak research. In particular, 607.8 nm and 645.3 nm spectral lines of SnII have been observed. Since the presence of tin in the discharge is strongly dependent on the heat load on the TLL surface, particular attention has been placed for the analysis to evaluate the Sn limiter surface temperature, by using the infrared fast camera data.

1. The cooled Tin liquid limiter

Tin physical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting point</td>
<td>232 °C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>2620 °C</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>66.8 W/(m-K)</td>
</tr>
<tr>
<td>Density</td>
<td>6.99 g/cm³</td>
</tr>
<tr>
<td>Heat capacity</td>
<td>0.21 J/(g*K)</td>
</tr>
</tbody>
</table>

3. First Results

In this first Tin limiter campaign, autumn 2016, experiments were performed with a standard ohmic FTU discharges (Ip = 0.5 MA, Bt = 5.4 T, n_e = 6x10^{19} m^-3) in which, progressively, the limiter was inserted very close to the LCMS.

In these discharges, the temperature of TLL surface reaches 1300 °C. The central part of the image is the TLL, while the sides are the reflections from the port.

The spectral lines of Sn have been observed in the visible range.

Spectroscopic measurements in the VUV region

Discharges with TLL. In the Fig.14 at the TLL surface temperature exceeds 1300 °C Presence of the tin in the plasma core, as observed by spectroscopy in VUV region, for experiments with high heat load on the TLL surface. For this discharge heat loads = 17 MW/m²

5. Final remarks

In the FTU plasma, for TLL surface temperatures below 1300 °C weak presence of Sn II spectral lines in the visible region and no observation of the Sn spectral lines in the VUV region.

For TLL surface temperatures > 1300 °C many spectral lines of Sn II are observed in the visible region further some lines in the VUV region.

For the first time in the world, a CPS tin limiter has been exposed to a tokamak plasma.

References

2) NIST Data Bases, www.nist.gov/atomic-spectra-database