

## Non-conventional plasma and sheath diagnostics: force probes and calorimetric probes

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The talk focusses on measurements of forces that low-temperature plasmas exert on a boundary. Two different discharge types are used: a microwave generated plasma and a parallel plate radio-frequency discharge. The force measuring probe uses a small test surface integrated into a grounded wall or a grounded electrode, respectively. It is found that the plasma exerts pressures in the order of magnitude of the electron pressure in front of the wall, where the plasma pressure can range from below the electron pressure to a few times the electron pressure. Moderate collisions in the plasma seem to enhance the pressure at the wall, whereas too many collisions reduce the pressure. A recently published model is discussed. Furthermore, another non-conventional diagnostic, the calorimetric probe, is shortly presented together with measurements.

Recently, we reported on simple experiments that allowed measurements of the forces exerted by low-temperature plasmas on boundaries [1,2]. The measured “plasma pressures” were in the order of magnitude of up to a few times the electron pressure close to the sheath edge, i.e. some 10 mPa.

The forces were discussed on the basis of a simple model taking into account the momentum fluxes across the sheath edge. It was concluded that ion-neutral collisions in the presheath can enhance the force caused by electron pressure and ion flux by a larger accelerated mass consisting of ions and fast neutral atoms.

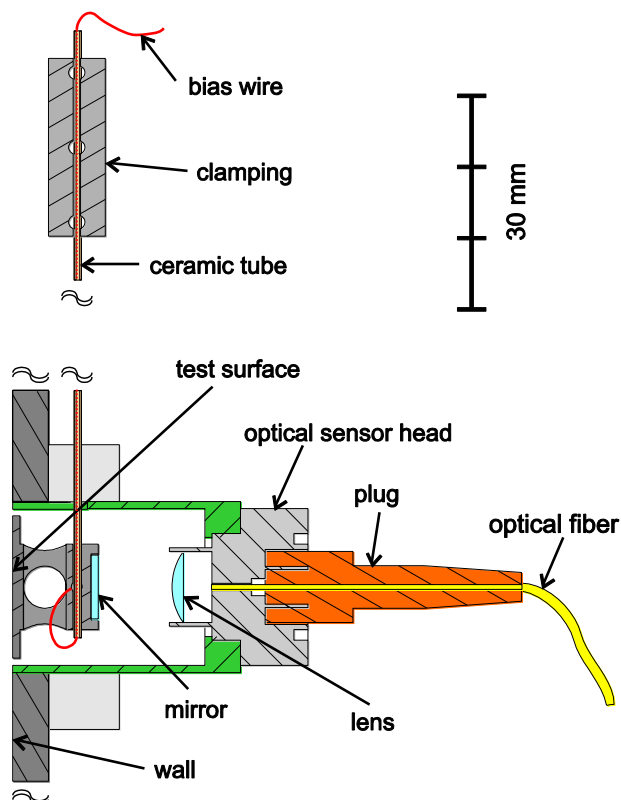


Fig. 1. Metal wall or electrode with integrated force probe. Only a small detail of the 170 mm disk is shown.

The force probe is based on a cantilever and a test surface attached to its free end. The displacement is measured interferometrically and translated into the causing force by calibration. Figure 1 shows the implementation of the wall with probe. The circular test surface is flush with front surface of the wall. Langmuir probes are used for the basic diagnostics of the plasma environments (microwave plasma and radio-frequency parallel plate discharge).

The measurements are discussed in the light of a model for plane geometry [3].

Currently, we are working on the application of additional diagnostics (retarding field analyzer and calorimetric probe), which are integrated in the wall similarly to the force probe.

### References

- [1] T. Trottenberg, T. Richter, and H. Kersten. Eur. Phys. J. D **69**, 91 (2015).
- [2] T. Trottenberg and H. Kersten. Plasma Sources Sci. Technol., accepted for publication (2017).
- [3] U. Czarnetzki and T. V. Tsankov, Eur. Phys. J. D **69**, 236 (2015).