TWO-DIMENSIONAL MULTIWIRE MONITOR FOR THE INVESTIGATION OF THE ATOMIC HYDROGEN BEAM

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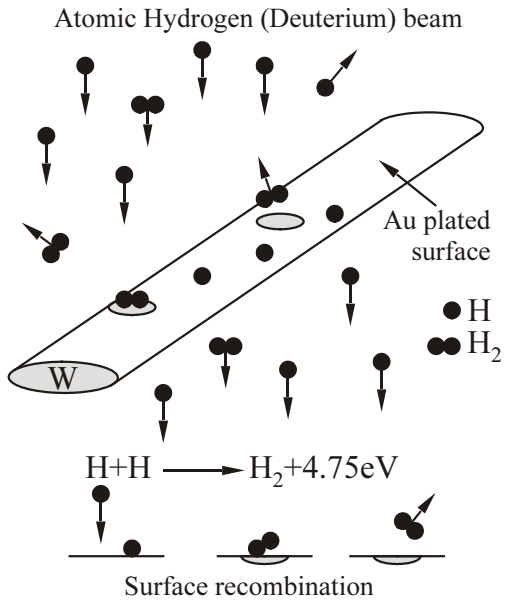

Fig. 1. Tungsten wire as a detector of the atomic hydrogen flux.

The present work is made in the framework of development of the polarized atomic beam source (ABS) [1] for the ANKE spectrometer in the COSY-Jülich accelerator and storage ring.

The monitor is based [2] on the deposition of atomic hydrogen (deuterium) recombination heat on the surface of gold-plated tungsten wires [3] of 5 μm diameter (fig. 1). The recombination heat causes a change of the electrical resistance of the wire. This resistance is the principal observable and its interpretation, based on solution of the differential equation of state, describing the temperature distribution along the wire, allows the determination of the hydrogen flux. The two-dimensional structure of the monitor (fig. 2) serves to estimate the center of the beam and its profile (fig. 3). The measurements were done with the atomic flux of 10^{16} atoms/s (average velocity is about 2000m/s) in the aperture of 15x15mm^2. Such flux corresponds to the heating power of the recombination of approximately 2μW.

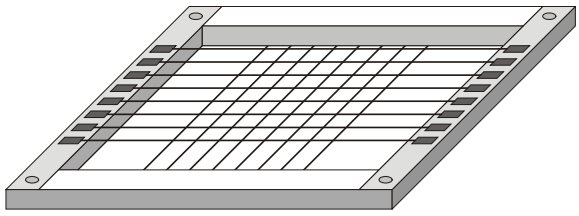

Fig. 2. Design of the monitor.

The beam profile estimation needs assumption about the shape of the beam, like a two-dimensional gaussian or any other distribution with appropriate free parameters. On the base of the measured wires' resistance the parameters of the beam can be found. The stability of the setup is demonstrated by the data of fig. 4. The resistance of one wire is plotted together with the data measured with a quadruple mass spectrometer (QMS). The atomic hydrogen beam intensity measurement with the QMS is the commonly used way of the beam investigation. The advantage of the wire monitor is the possibility to use it as an online device. The sensitivity of the method is demonstrated in the fig. 5. The method is independent of the vacuum conditions due to the similarity of the resistance dependencies in a good vacuum and with a molecular hydrogen flux.

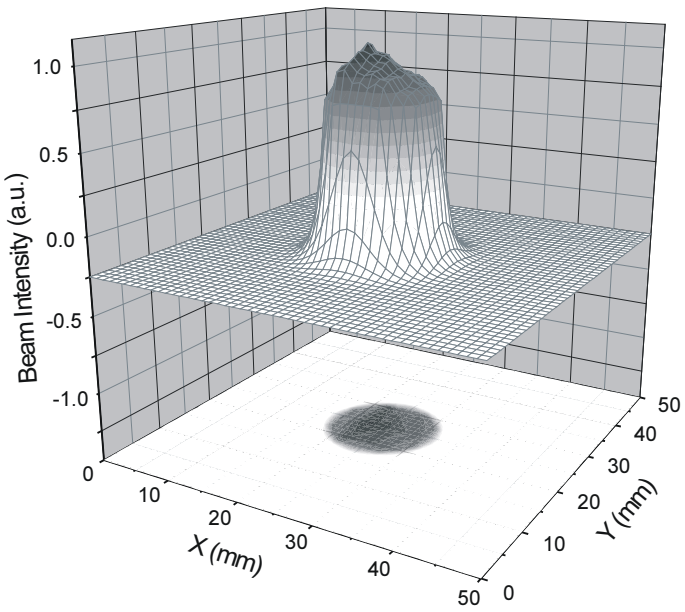

Fig. 3. Off-line calculated beam profile.

The temperature of the wire depends on the current through the wire and can be varied up to 1000°C. This can be used for the investigation of the sticking time and the surface recombination on the wire as a function of the temperature. Covering of the wire surface by different metals (Au, Pt, Ni and Al) with electro-chemical methods allows to investigate the process of the surface recombination for different materials. Surface recombination of the atomic hydrogen is of utmost interest in the surface physics [4].

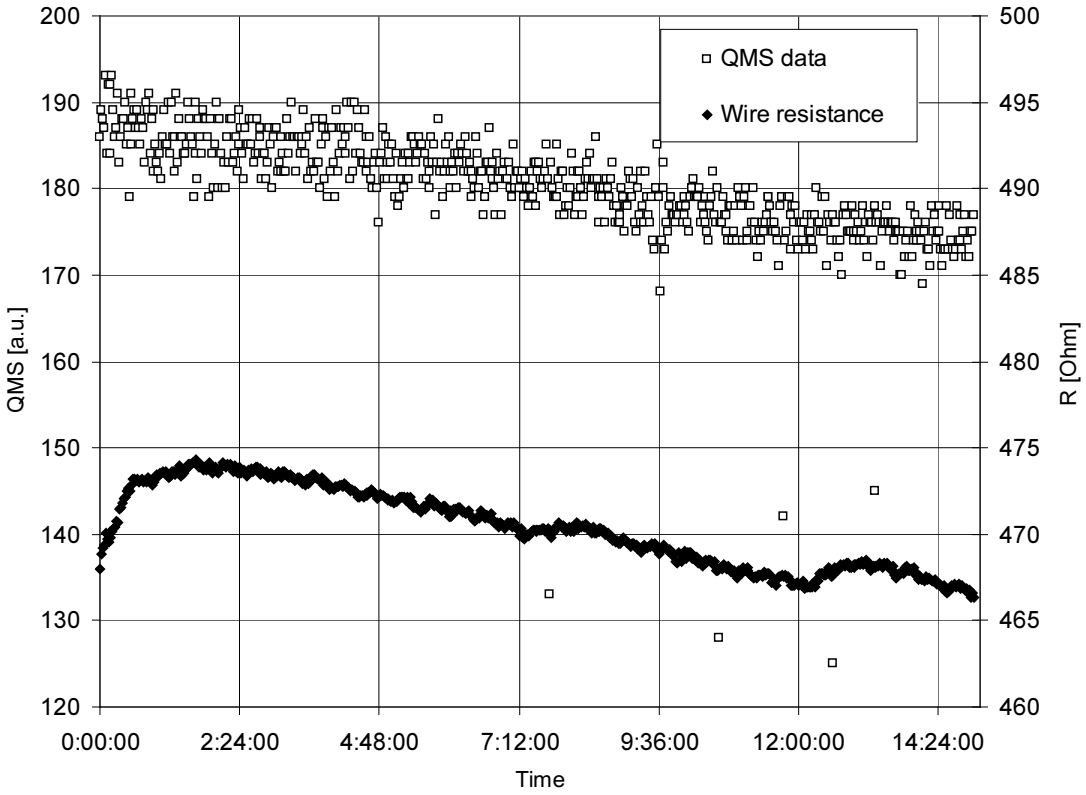

Fig. 4. Time stability of the atomic hydrogen beam measurements by QMS and single wire.

A special procedure of the wire cleaning at 1000°C in the flux of atomic hydrogen provides the reproducibility of results after the filling of the monitor vacuum chamber with air. The measurement of the resistance as a function of the current at a chamber pressure of about 10^{-7} mbar yields the necessary calibration curve for each wire and eliminates possible inhomogenities.

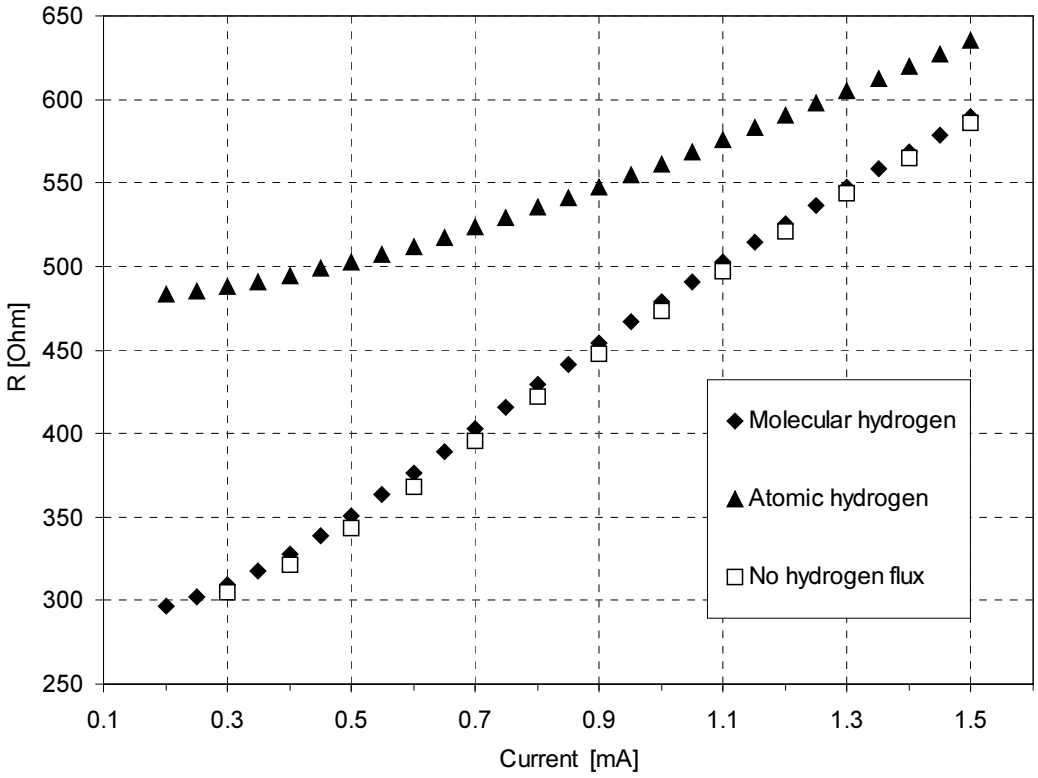

Fig. 5. R-I dependence for the single wire.

The main features of the novel detector allow:

- measuring the hydrogen flux of atomic beam source;
- investigating of the beam profile close to the nozzle;
- on-line monitoring during the ABS operation;
- other studies, like those of the surface recombination process.

REFERENCES

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