Investigations on the Activation- and Saturation Process of NEG Getters

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Non evaporable getter (NEG) coatings have become relevant in many particle accelerators during the last years. Beside RHIC at BNL, LHC and LEIR at CERN and others, also at GSI getter films are used in the heavy ion synchrotron SIS 18 [1,2]. The applied films have established their full performance in the accelerators, however we have investigated the activation and saturation behavior as well as the aging of the getters in detail with a dedicated test bench and for the first time by ion beam analysis.

NEG getters consist typically of the elements Ti, Zr, and V. During pumping the metals are cumulatively terminated by oxides, carbides and nitrides, hence the pumping speed is decreasing. The reactivation of saturated NEG is done with high temperature, typically at the end of the UHV bake out. Here, the surface metal-gas-compounds dissolve and the gas is transferred to the inside of the layer.

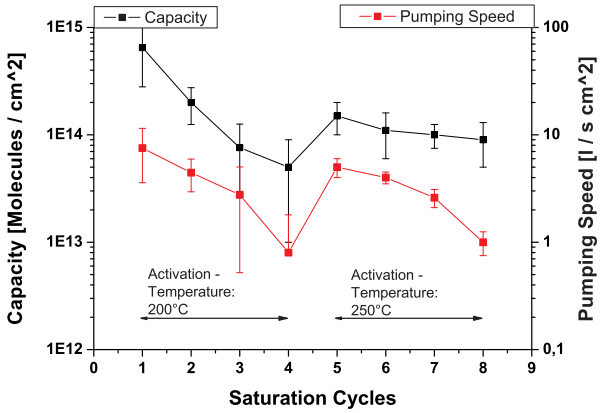

Fig. 1: Aging of the NEG film: Capacity (black) and pumping speed (red) versus number of activation/saturation cycles.

To study the pumping performance of getter films in detail we have built up a test bench, consisting of a NEG coated DN-CF150 tube of 300 mm length. On one end a pumping post is connected to the tube and on the other side a gas inlet system, both by a conductance. The pressure in all three chambers is measured by extractor gauges. During gas injection the flux into and out of the NEG chamber is measured by $\Delta p \cdot C$ where C is the respective conductance. Dividing the difference of the gas fluxes by the pressure inside the coated tube we obtain the pumping speed of the NEG. Integrating the difference of the gas fluxes over time determines the capacity of the getter film since the coated area is well known. We have placed several square shaped coated samples inside of the NEG tube. Samples and tube were coated together giving equal film stoichiometry and thickness (roughly 1500 nm as measured by RBS). After activation the getter is saturated by CO. Then, the NEG tube is opened and one sample is extracted. Thus we obtain a series of samples activated once, twice, three times and so on. Typically one cycle of bake out, activation, saturation and dismounting takes one week.

We have obtained pumping speed and capacity values for eight cycles so far, whereas after four cycles the activation temperature was increased from 200°C to 250°C. The activation time was 24 h except for sample 8 that was activated 48 h. Fig. 1 shows values for the capacity in molecules per cm^2 and pumping speed in liters per second and cm^2. The decrease of the getter performance as well as the activation temperature shift are visible.

In addition to the aging measurements of the NEG films we have monitored the gettering process by ERDA. This ion beam analysis gathers element specific depth profiles by detecting sample atoms after they were elastically scattered by a heavy ion beam. Details are described elsewhere [3]. Since the saturation gas in our experiment is always CO we concentrate the ERDA examinations on the C and O amount inside of the metallic components. Fig. 2 shows the result of the first four samples. Oxygen (blue) and carbon (red) is plotted for the virgin sample and for three following activation / saturation cycles from light to dark color respectively. However the complete analysis is ongoing, it is already visible that carbon is augmented at the surface (at channel 450), while oxide (surface at channel 550) is incorporated into deeper layers, meaning lower channels as indicated by the arrows.

In future the results will be compared to XPS measurements and, depth dependant concentration profiles will be calculated.

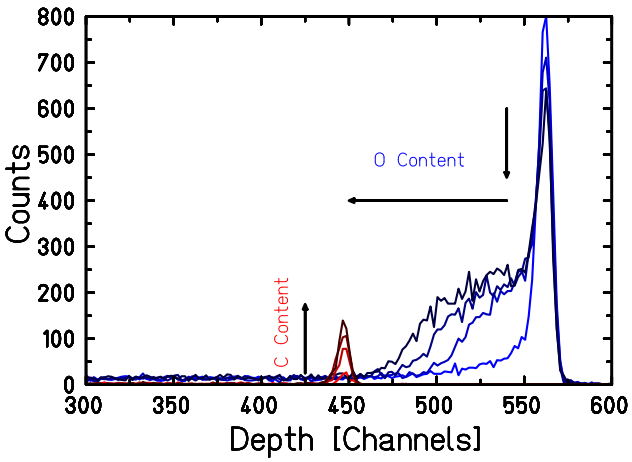

Fig. 2: Element concentration vs. depth inside of the getter film.

References

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[2] M.C. Bellachioma *et al.*, GSI Report **2007-1** (2008) 91
[3] W. Assmann *et al.*, Nucl. Instrum. Meth. **B89** (1994) 131