Nanomembranes Modified by Highly Charged Ions

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Smart membranes play a key role in different sensor applications, e.g. for drug and explosive detection. By tailoring the structure and properties of these membranes physical-chemical functionality can be added to the sensor. One way of modifying membranes is by particle irradiation with electrons or ions. Specifically, highly charged ions (HCI) carry a large amount of potential energy (the stored ionization energy) which is released when interacting with the membrane creating nanopores by a single HCI impact. In order to be able to control the ion induced modification, e.g. defining the pore size, the energy deposition in the membranes has to be determined.

For the interaction of HCI with thin membranes this is particularly interesting because the HCIs are still in a pre-equilibrium interaction regime for thicknesses below a few nm. Within 1 nm thick carbon nano membranes (CNMs) for instance, holes are produced by the passage of highly charged Xe^{q+} ions only above a threshold in the potential energy of the HCI which depends on the kinetic energy [1]. In order to study the stopping force of the HCIs in the membrane we examined the charge state and the energy loss of the Xe^{q+} ions after their passage through the CNM. Surprisingly, two distinct exit charge distributions were observed [2]. While some of the ions pass the membrane with almost no charge loss, other ions lose most of their charge. Apparently, the observed charge distribution reflects two different impact parameter regimes. The different impact parameter regimes are also connected to different energy losses: ions with large impact parameters are not stopped, w hereas ions in close collisions exhibit high stopping force which is strongly dependent on the incident charge state.

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