Charge-patch enhanced surface scattering in the transmission of hundred-keV proton through tapered glass capillary

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Synopsis Based on our previous work for proton transmission in nanocapillary, the simulation of hundred-keV protons through tapered-capillary was conducted. The deposited charge patch, small-angle scattering under surface as well as surface scattering were considered. We found, only the charge patch could not make the transmission effective. The charge-patch-assisted surface scattering make the density be enhanced.

Taper glass capillary has been attracting many attention as a focusing device for different ions. For keV-energy highly charged ions, the focusing ratio is about 1-7 [1], where the deposited charge patch is dominant. For MeV ions, it can be as large as 100 [2], by the small-angle scattering of incident ions. For hundred-keV protons, the focusing ratio can be 6 and decreased as E^{-1} [3]. But the scenario of hundred-keV ion transmission through tapered-capillary is not clear.

Based on our previous work [4], the simulation of hundred-keV protons through tapered-capillary was conducted. We want to identify the primary reason for the distinct focusing ratio of ions with different energies ranging from keV to hundreds of keV and even MeV. The relative size of capillary is same to Ref. [3], where the ratio of outer to inner diameter is 0.33. In simulation, the charge patch, small-angle scattering and surface scattering are considered.

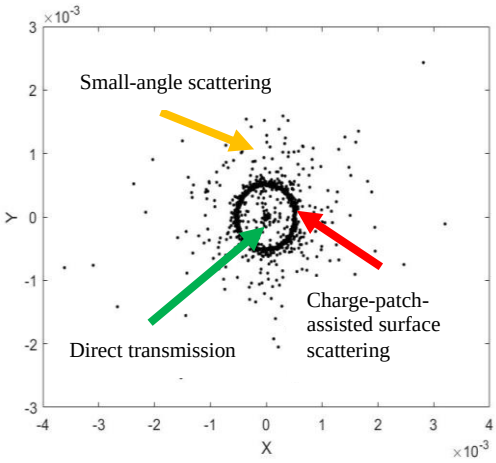

Figure 1. Position of transmission proton of 100 keV for incident angle along the axis.

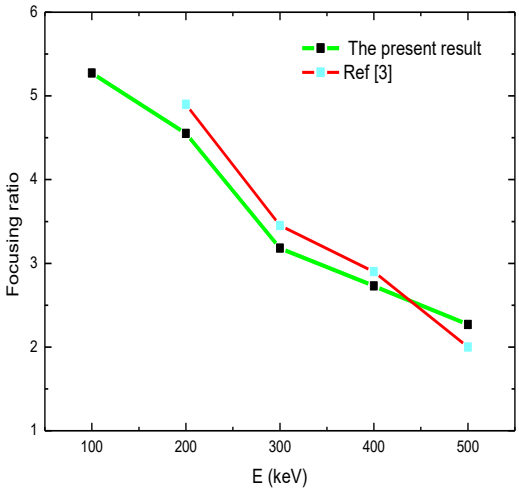

Figure 2. Focusing ratio changed with energy

Figure 1 is the position of proton outer of capillary. The charge-patch-assisted surface scattering is dominant in the three process. In figure 2, the focusing ratio changed with the incident energy are plotted and compared with experimental results [3]. The focusing ratio decreases with the incident energy.

References

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