Controlled fabrication of ion track nanowires and channels

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We describe a system for fabricating prescribed numbers of ion track nanochannels and nanowires from a few hundred down to one. It consists of two parts: first, a mobile tape transport system, which, in connection with an ion beam from a heavy-ion accelerator (nuclear charge Z above 18 and specific energy between 1 and 10 MeV/nucleon) tuned down to low flux density by means of defocusing and a set of sensitive fluorescence screens, can fabricate a series of equidistant irradiation spots on a tape, whereby each spot corresponds to a preset number of ion tracks. The tape transport system uses films of 36 mm width and thicknesses between 5 and 100 μm. The aiming precision of the system depends on the diameter of the installed beam-defining aperture, which is between 50 and 500 μm. The distance between neighboring irradiation spots on the tape is variable and typically set to 25 mm. After reaching the preset number of ion counts the irradiation is terminated, the tape is marked and moved to the next position. The irradiated frames are punched out to circular membranes with the irradiation spot in the center. The second part of the setup is a compact conductometric system with 10 picoampere resolution consisting of a computer controlled conductometric cell, sealing the membrane hermetically between two chemically inert half-chambers containing electrodes and filling/flushing openings, and is encased by an electrical shield and a thermal insulation. The ion tracks can be etched to a preset diameter and the system can be programmed to electroreplicate nanochannels in a prescribed sequence of magnetic/nonmagnetic metals, alloys or semiconductors. The goal of our article is to make the scientific community aware of the special features of single-ion fabrication and to demonstrate convincingly the significance of controlled etching and electro-replication.