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Development of high brightness ion sources for nuclear microprobe applications, aiming for sub 10 nm spot sizes

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Microscopy and miniaturization have been an integral part of scientific progress. Since MeV protons mainly interact with substrate electrons and the fact that proton induced secondary electrons just get enough energy to break bonds, a proton beam will follow a straight path through tissue or resist material. Proton microscopy has therefore several unique advantages over other forms of microscopy. The current downside is the poor source performance, about a million times less bright compared to electron beam sources. The success of a next generation proton microscope depends on two main components: a stable high brightness source of MeV protons and a high quality focusing lens system. We have demonstrated 9.3 x 32 nm^2 proton beam focus and have written 19 nm wide (100 nm tall) lines in HSQ resist. To address the limited brightness we are developing a new ion source based on electron impact ionization. Recent tests with "on chip ion sources" have shown potential to improve the ion beam brightness by a million times. This will allow us to develop a table top proton microscope capable of delivering sub 10 nm beam spot size for MeV protons. This new source will therefore enable: Sub 10 nm 3D nanofabrication without "proximity effects", sub 10 nm whole cell imaging, opening up new pathways to investigate the uptake of nanoparticles in drugs delivery. Since 0.5MeV protons will cause double stand breaks in DNA, this new system will provide an insight to improve cancer treatment in radiobiology using 200MeV protons.

Biography

Jeroen A van Kan obtained his PhD in Physics (University of Amsterdam) in 1996. In 2007, he received the Institute of Physics Singapore, Omicron Nanotechnology Award. Currently, he is Professor in the Department of Physics, Singapore. In his research, he employs fast light ions for lithography and analysis. In his research group new methods are developed for next generation 3D nano-lithography with an emphasis on ion beam focusing and ion source development. He also uses nano-imprint lithography for single DNA molecule studies in nano-fluidic lab on chip devices. His work has resulted in 146 scientific publications and 17 research grants.

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