Self-Assembled Magnetic Particles in Lab-on-Chips as Sieves, Affinity Columns and Microreactors

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We present a new approach to bioanalysis in microchannels, using superparamagnetic nanoparticles as a self-organizing matrix. In a magnetic field, the colloidal suspension forms a 2-dimensional array of columns with micrometer-sized spacing. This rigid matrix reverts back to a low viscosity suspension when the field ceases, allowing easy replacement between runs. Varying the configuration of the channel and magnetic field, it is possible to create organised matrices with pore sizes ranging from sub-micrometers to 50 µm. Submicrometer arrangements are suitable for capture or digestion of proteins with high specificity and kinetics, opening the route to online protein digestion and prefractionation for protomic “lab-on-chips”. In matrices with a pore size comprised between two and five micrometers, we were able to perform separation of large DNA (from 10 to 160 kbp) in two minutes. Arrays of antibody-labeled particles, with pore sizes larger than 10 µm were prepared and applied to the sorting of cells, as an alternative to batch magnetic sorting and to flow cytometry. This strategy combines a high capture efficiency with unprecedented power for molecular typing. It is currently in clinical validation at Curie Institute, towards the typing of circulating tumor cells for the prevention of metastatic cancer relapses.

References


Jean-Louis Viovy is Research Director (full time permanent researcher) at “Laboratoire Physicochimie Curie”, a joint research laboratory between CNRS (French National Research Center) and Curie Institute, where he heads an interdisciplinary group of about 30 persons, dedicated to the development of tools for biology and medicine. His interests involves two main lines of research: Single molecule biophysics studies aimed at the understanding of DNA-protein interactions, and microfluidic technologies for biomedical analysis. Some of the technologies for mutation analysis developed by the group are in use in several clinical laboratories for routine diagnosis of cancer predisposition. Author of more than 150 scientific articles, he regularly coordinates EU projects, and is member of the board of the Chemical and Biological Microsystems Society, of the Programme Committee of MicroTAS, and of the French Nanoscience agency committee. JL Viovy is also a cofounder of the startup “Fluigent”, selling worldwide microfluidic instruments, and diagnosis tools. and was awarded the French Innovation Agency award for advanced technology entrepreneurship.

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