Dielectrophoretic approaches to microscale sample preparation

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Easy to use instruments tolerant of a wide range of operating environments and capable of accomplishing automated analysis will enable diagnostic advances to be disseminated from sophisticated clinical laboratories to points-of-care including rural and remote locations as well as hostile environments such as space. The realization of such instruments demands that sample preparation steps be carefully addressed. Frequently, diagnosis requires that target cell subpopulations from a specimen be discriminated, isolated and lysed and then subjected to molecular analysis. The ability to achieve all preparative and analysis steps within a single, integrated device would be of clear benefit to automating the entire diagnostic process. In this presentation, dielectrophoretic methods applicable to sample preparation are described. Dielectrophoretic effects, which are ideally suited to integrated microfluidic applications, arise from inhomogeneous and/or travelling electrical fields created by microelectrode arrays that can be energized by logic-level signals and can be easily controlled by microcircuits. Dielectrophoresis allows the trapping, focusing and translation of cells within their carrier medium as well as the subtle discrimination and separation of different cell types according to their intrinsic dielectric differences. These differences can be exploited with extreme sensitivity so that the need to label target cells, as demanded by most separation techniques, can usually be avoided. Several illustrative applications of AC electrokinetic effects in microfluidic devices are demonstrated including cell discrimination and separation, blood cell differential analysis, the discrimination and isolation of cancer cells from cell mixtures and blood, and the targeted lysis of cell subpopulations in cell mixtures. The combined use of these methods to create sample preparation front ends for microfluidic diagnostic chips is discussed.