366d A Microfluidic Platform for Rapid Screening of Separation Performance in Gel Matrices for DNA Electrophoresis

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Although microfabricated devices have the potential to offer a portable low-cost alternative to conventional DNA analysis equipment, a major problem with the microdevice format is the requirement that electrophoretic separations be performed over much shorter distances than those encountered in conventional macroscale systems. Ultimately, it would be desirable to quantitatively determine the achievable level of separation resolution directly from measurements of fundamental physical properties associated with the gel matrix. Unfortunately, this predictive capability is currently lacking, largely because the required experiments are extremely tedious and time consuming resulting in a critical lack of literature data. We address this issue through the use of microfabricated gel electrophoresis devices incorporating on-chip arrays of electrodes, heaters, and temperature sensors to measure diffusion and dispersion of single- and double-stranded DNA fragments in crosslinked polyacrylamide gels. The microdevice format allows a complete set of diffusion and dispersion data to be collected in approximately one hour, as opposed to experiment times lasting several days using conventional sequencing equipment. We examine the influence of operational parameters including buffer composition, temperature, gel composition, and electric field strength in order to identify the conditions that yield optimum separation performance. Results are compared with corresponding measurements in a macroscale slab gel DNA sequencer.