294d Enhanced DNA Separations in Microchannels Via a Novel Polymer Architecture: Physically Crosslinked Polymer Solutions

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A novel class of DNA separation media, “physically crosslinked” polymer networks, has been created which could meet the demands of increased separation performance within the bioanalytical community. Poly(acrylamide-co-dihexylacrylamide), with as little as 0.13% mol dihexylacrylamide, yields remarkably improved electrophoretic DNA separations when compared to a linear polyacrylamide (LPA) of matched molar mass. Single-molecule DNA imaging reveals a novel separation modality, resembling inch-worm movement, which we name “stationary entanglement coupling.” Physically crosslinked gels have three distinct concentrations regimes that have dramatic consequences a ,ηon electrophoretic DNA separations. At concentrations below C concentration similar to C* (the overlap threshold) in unmodified polymers, DNA separations are faster than in LPA and have equal resolution. At concentrations above CT, the concentration where the polymer chains become elastically effective (i.e., become hydrophobically associated intramolecularly), the separation of DNA is comparable over most sizes of DNA; however, improved separation performance is seen for DNA smaller than 30 base pairs. At but below CT, the separation performance of DNAηconcentrations above C in LPA-co-DHAs is substantially superior. Using these media, several hundred base-pairs of DNA have been sequenced in microfluidic devices, with single-base resolution, in under 10 minutes and with high peak efficiencies and excellent results compared to matched-molar mass LPA. Physically crosslinked systems offer significant advantages over both linear polymers because of separation performance (or speed) and covalently linked crosslinked gels because the physical crosslinks can be broken (reversibly) with applied shear, and loaded into microchannels.