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Accurate, repeatable, and replaceable constraint of capillary arrays using a micro-fabricated device

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Capillary arrays for electrophoresis instrumentation are typically purchased as a pre-packaged assembly, with 16—96 capillaries bonded onto a support bracket. To replace an inoperable, relatively inexpensive (~$5) capillary after merely 300 runs or bad fortune, one must typically replace the entire assembly (~$1K-$5.5K). We report the design, manufacture, and testing of a device which constrains one hundred capillaries and can be scaled to thousands, while permitting individual replacement and alignment. The device fundamentally consists of a sandwich of steel, silicone, and steel and contains an array of thru-holes manufactured by microelectrode discharge machining (microEDM) and laser micro-machining. A plunger is first fabricated using wire EDM, and then the hole array is die-sunk with the plunger through 5 mm thick steel plates. The hole array in the silicone layer is pre-drilled with a 75 W CO_2 laser. Clamping the sandwich compresses the silicone. Lateral deformation of the silicone, defined by the Poisson ratio, locates and seals around capillaries inserted loosely through the holes with alignment tolerances of 250 µm axial and 25 µm radial, spaced 1 mm apart. An axial load constraint limit of 3 N is achieved. These tolerances are sufficient for optical detection alignment, separation matrix injection, and operation. The design offers replaceability by unclamping the sandwich as well as sealing against fluid flowing axially. This device could contribute to consumable cost and downtime reduction for capillary array electrophoresis instrumentation.