Feasibility Study of MEMs Technique for Characterizing Magnetic Susceptibility of Subcellular Organelles

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All materials experience a force when placed in a region of magnetic field and field gradient. The magnitude of this force depends on the magnetic susceptibility of the material and this varies over a wide range depending on the type of material. Our goal is to develop a technique for evaluating the magnetic susceptibility of cells and subcellular organelles so that scientists can access to develop new methods to modify or modulate internal cellular forces. Research studies have shown that forces in the piconewton range can affect cellular behavior. Internal forces of this magnitude can occur in cells exposed to high intensity magnetic fields, if the difference in magnetic susceptibility of subcellular organelles is as low as 10%. Because the magnetic susceptibility x is expected to be on the order of 9×10^{-6}, the proposed measurement technique must be extremely sensitive. In this paper, a pilot study is described in which the feasibility of a magnetophoresis technique is explored. Tests implementing magnetophoresis for polystyrene test particles ($|x|=8.21\times10^{-6}$) with a 100 μm diameter explored the sensitivity and accuracy effects of varying fluid flow speeds of 0.63 mm/s, 1.09 mm/s, and 1.44 mm/s, particle radius to channel depth ratios (r/a) of 0.043 and 0.199, and a magnetic field and gradient product ($B^{*}dB/dz$) of 38.91 T^2/m. The percent uncertainties of the experimental magnetic susceptibilities for the three different flow speeds and r/a ratio combinations studied are 12.3%, 18.3%, and 22.4% (in order of flow speed). The trial runs indicate that a balance of a larger r/a ratio and a slower flow speed is ideal to optimize consistency in flow velocities and calculated magnetic susceptibilities while minimizing uncertainty. Requirements for MEMs device design are also presented.

Design of an Autoclavable Active Cannula Deployment Device

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Concentric tube continuum devices, known as active cannulas, consist of multiple precurved elastic tubes that extend telescopically and rotate axially with respect to each other. Through these degrees of freedom, an active cannula presents a dexterous and versatile "tentaclelike" mechanism for accessing targets in minimally invasive surgery. Deploying an active cannula in a practical surgical setting requires a sterilizable device capable of specifying positions and trajectories for each degree of freedom. While robotic devices will likely enable this to be done most efficiently in the future, initial clinical feasibility studies are best undertaken with manual devices. In this paper, we present specifications, design, and development of a manual (that is, not motorized) active cannula deployment device.

