A.5: Fabrication of Ferrofluid based micro fluidic device using X-ray lithography beamline (BL-07)

A prototype of micro fluidic device based on nickel ferrite ferrofluid using x-ray lithography beamline is designed. Magnetic nanoparticles dispersed in a carrier liquid (e.g. poly ethylene glycol) can be forced to migrate or diffuse in a magnetic field gradient in designed micro fluidic channel. The force applied by the magnetic field on the nanoparticle can be transferred to the fluid making it to flow or stop. A travelling magnetic field is designed using Cu coil and this is energised by providing current in quadrature to generate magnetic field. The four phase power supply is custom designed by the Power Supply Division, RRCAT for this purpose.

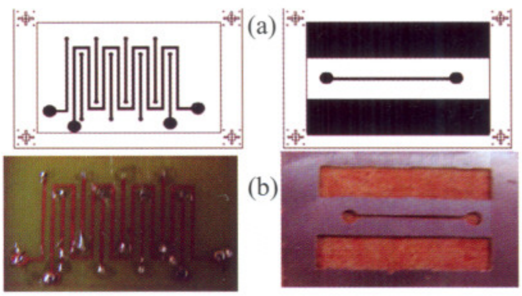

Fig. A.5.1: (a) UV Mask design (left) for travelling magnetic field structure, (right) for stainless steel X-ray mask (b) fabricated electrode pattern on Cu PCB and fabricated SS X-ray mask.

UV mask for electrode pattern for generation of travelling magnetic field and mask for making stainless steel (SS) x-ray mask is designed (Fig. A. 5.1(a)). Using UV photolithography followed by etching, copper electrode pattern and SS X-ray mask is fabricated (Fig. A.5.1(b)).

X-ray sensitive photoresist (SU-8) of thickness 325 μm is spin coated on electrode pattern side of Cu PCB substrate. SS mask and SU-8 coated substrate are mounted in X-ray scanner (experimental station) of Soft and Deep X-ray Lithography beamline. X-ray energy band of (5-10keV) is used to create X-ray mask pattern on SU-8 photo resist. The fabricated prototype of micro fluidic device is shown in Fig. A.5.1(a). This device is filled with ferrofluid (Nickel Ferrite nanoparticles dispersed in PEG) and prepared for flow rate measurements (Fig. A.5. 2(b)).

Micro fluidic device is connected to power supply. Schematic of electronics test setup used for flow rate measurement is shown in Fig. A.5.3. Current (A) is varied by keeping the frequency constant (in the range 1-40kHz) and flow rate of ferrofluid in micro fluidic channel is measured. Speed is calculated by measuring time required by fluid to flow between points (points A and B) of distance 615μm (Fig. A.5.2 (b)). Speed of ferrofluid at different current and constant frequency is show in Fig. A.5.4. The maximum speed of 301 μm/s is measured at frequency of 10 kHz and 6 A applied current.

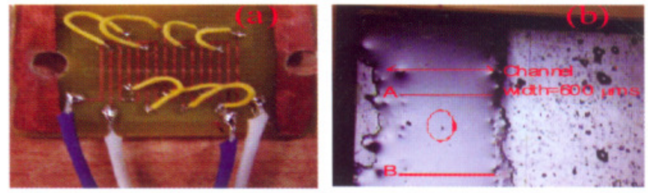

Fig. A.5.2: (a) Fabricated prototype of micro fluidic device and (b) photographs showing part of micro channel filled with ferrofluid during flow rate measurement.

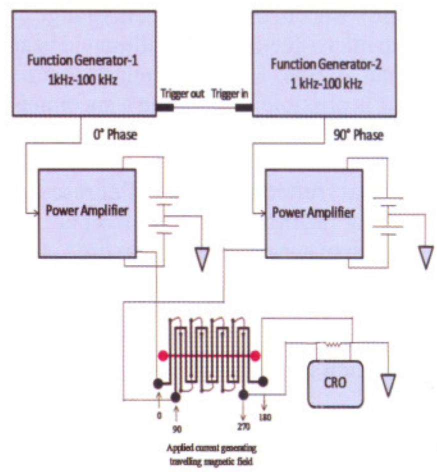

Fig. A.5.3: Block diagram of electronics test setup for ferrofluid flow rate measurements.

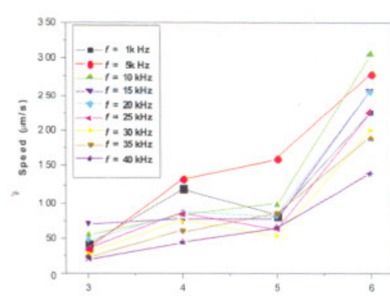

Fig. A.5.4: Flow rate measurement of Nickel Ferrite ferrofluid at different current (A) keeping the frequency (kHz) fixed.

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