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Micro-Rod Particle Dynamics in the Nematic Phase of Liquid Crystals Under Electric Fields

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INTRODUCTION & AIM

Investigating micro-rods with different aspect ratios leads to a wealth of additional degrees of freedom for motion as compared to the translation observed for spherical particles [1]. The significance of aspect ratios in influencing the dynamic behaviour of micromaterials in various settings is investigated in this work. Our experiments have unveiled novel modes of motion encompassing both linear and nonlinear dynamics for rod-shaped particles in a nematic liquid crystal under the influence of an electric field. The observed behaviours include linear translation, circular motion, and a newly characterized pattern involving rotation around the short axes of the rods, obviously absent for spherical microparticles. Additionally, we identified novel macroscopic modes of motion, such as looping and logarithmic spiral trajectories[2].

METHOD

The basic setup involves:

- Polarising optical microscopy (POM)
- Function generator
- Voltage amplifer

Progress:

- Micro-rods with various lengths were used to introduce shape anisotropy, resulting in micro-materials with varying aspect ratios.
- 5CB was used as the liquid crystal (LC), which maintains a stable state at room temperature. The LC material was injected into a custom-made ITO glass cell.
- The sample was prepared through a four-stage process involving cleaning, coating, aligning, and filling the sample.
- The movement of the micro-rods through the liquid crystal was encouraged through the reduction of an electric field with variable amplitudes, frequencies, and waveforms.

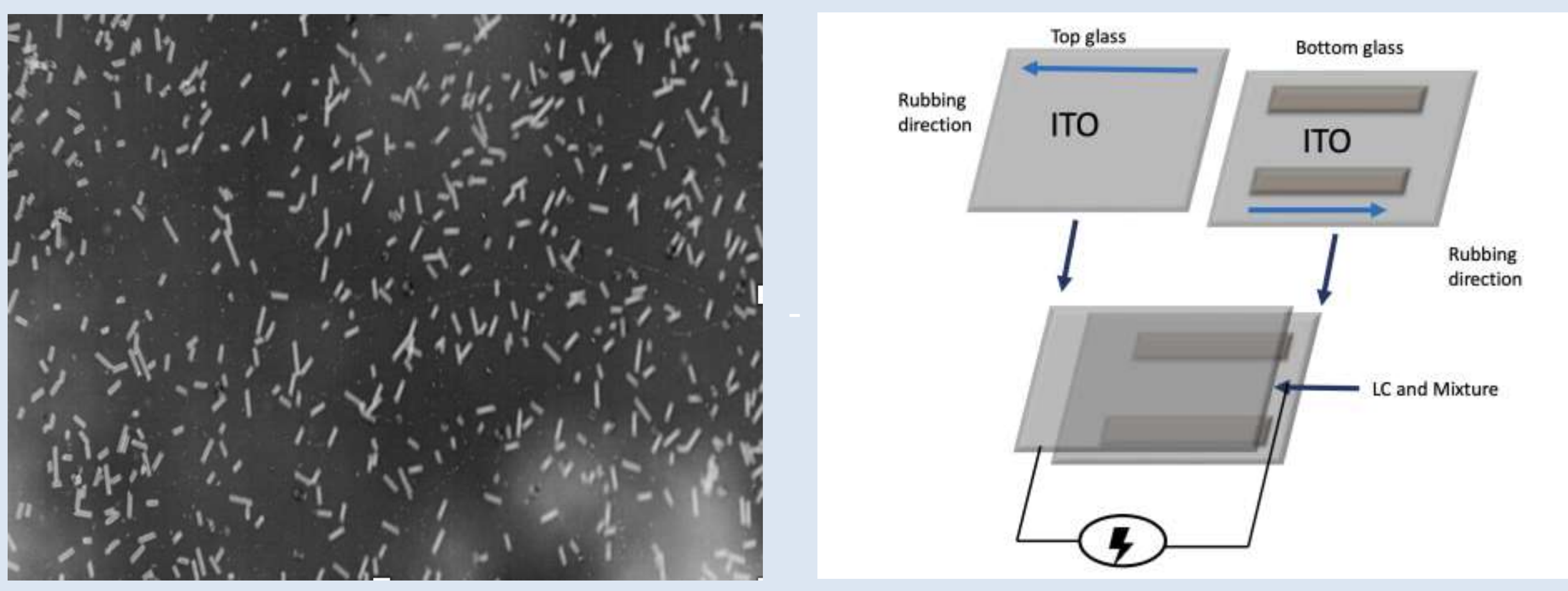

Figure 1: Optical polarizing photographs of silica and microrods (right) and Schematic diagram of a planar cell preparation (left).

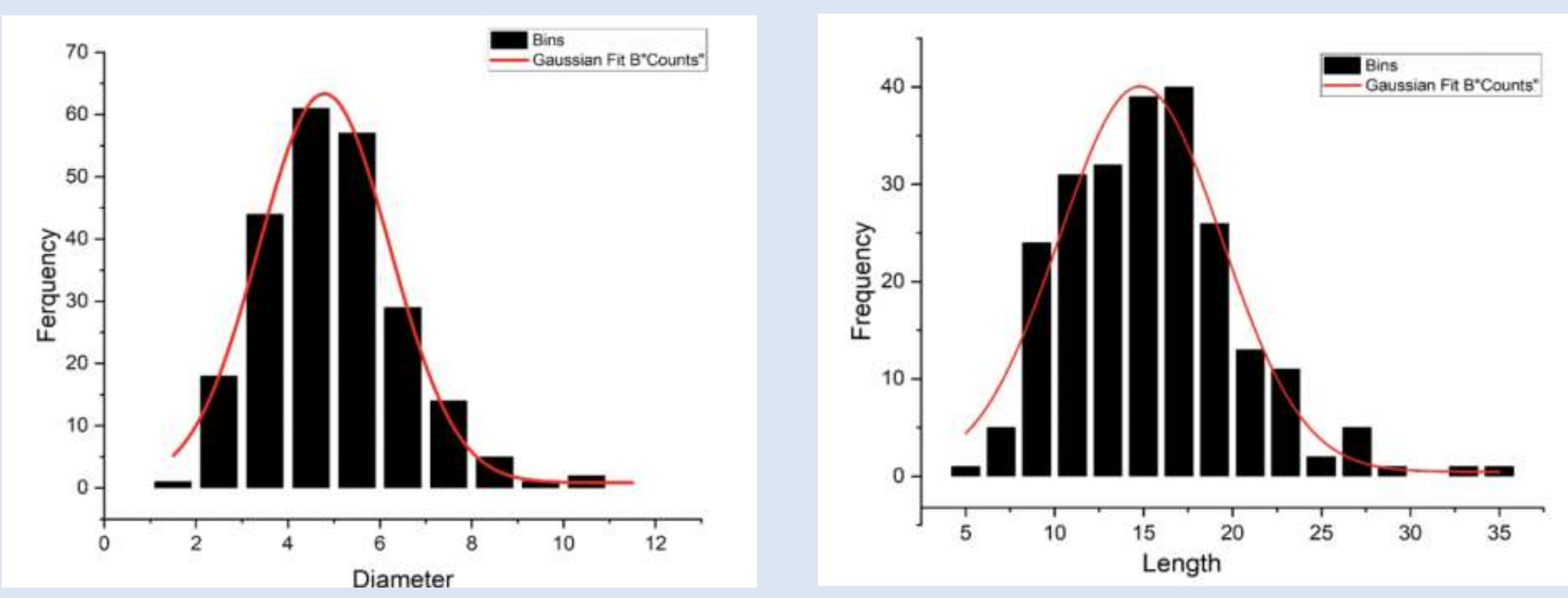

Figure 2: Their size (diameter and length) distributions. The mean values of the sizes are given in the inset of the graph.

RESULTS & DISCUSSION

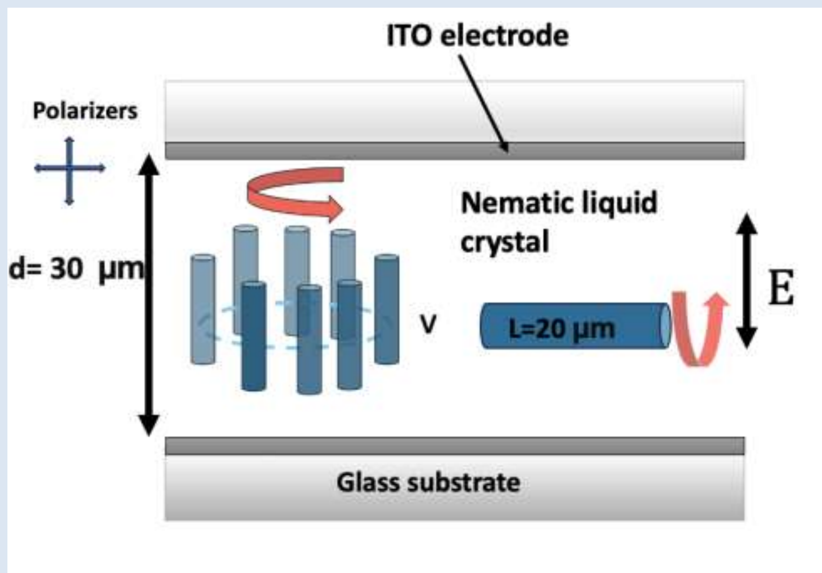

Figure 3:Schematic diagram of a planar cell preparation

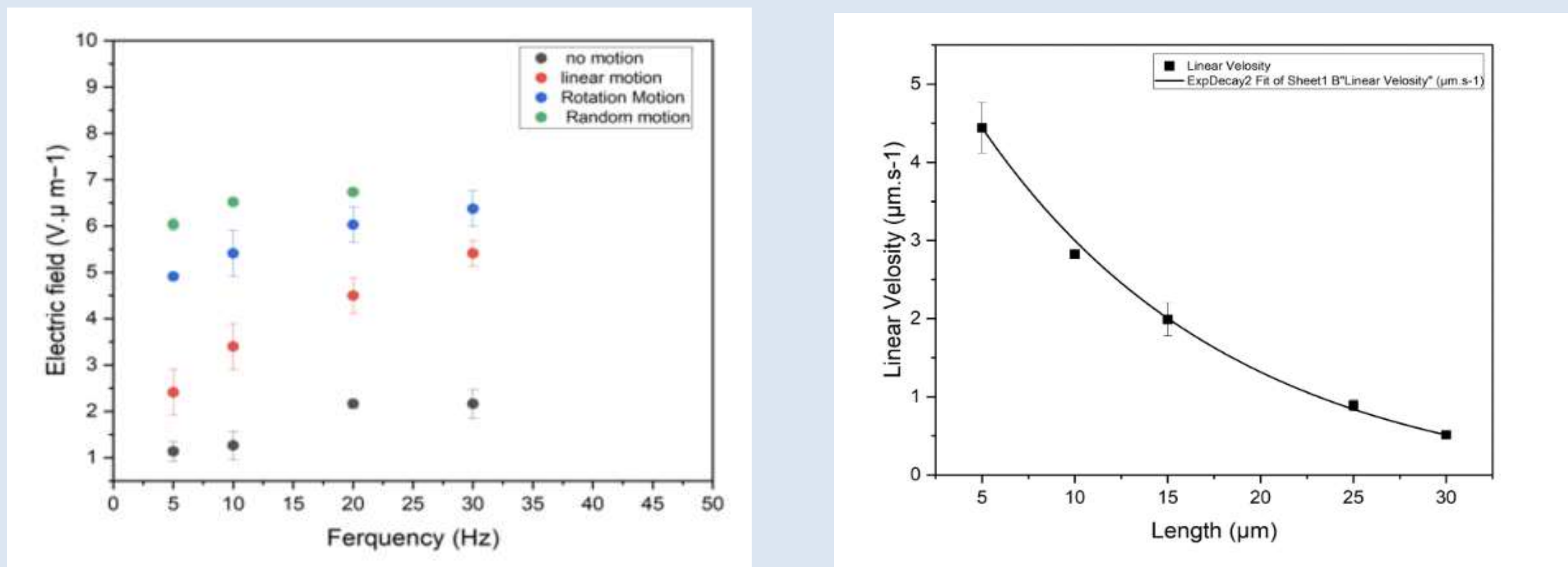

Figure 4: Stability regimes of field amplitude-frequency for micro-rods (left) and (right). Relationship between the particle length and linear velocity

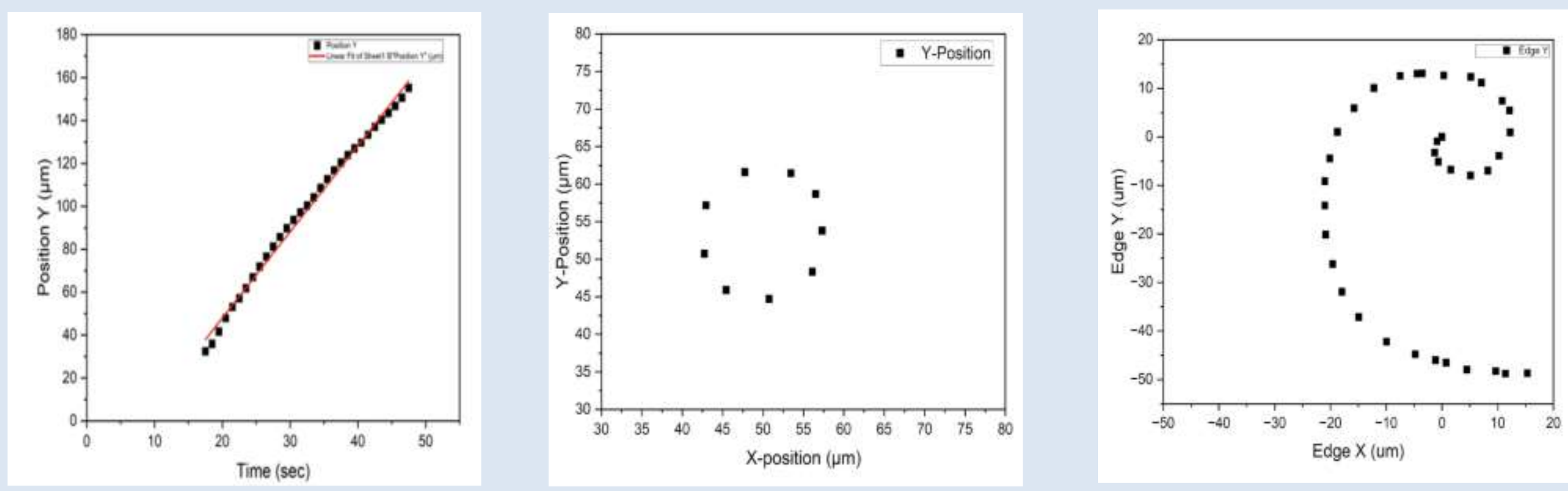

Figure 5: Models (linear, circular , logarithmic spiral motion) of micro-rod particle path in the liquid crystal sandwich cell plane.

CONCLUSION

- Micro-rods show unique behaviour due to shape anisotropy, unlike spherical particles. Aspect ratio and length determine their motion patterns.
- New motion patterns observed linear and circular motion, and rotation around short axes.
- Motion characteristics depend on particle size, cell gap, temperature, and electric field frequency.
- The results have broad implications for particles with different geometries.

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