Development of Liquid Crystalline Microactuators

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Objective
The application of liquid crystals has been for the most part limited to displays such as Tvs and PCs. We discovered an innovative principle, which is to apply liquid crystals as driving power for micromachines. Imposition of electric fields on liquid crystals induces flows, whose profile and magnitude are assumed to depend on the strength of the electric field, the representative length, and tilt and twist angles of the director (the local average of liquid crystal molecules) on walls. Our final goal is to develop microactuators driven by liquid crystals, and the present objective is to study unsteady behaviors of liquid crystals under electric fields both numerically and experimentally.

Project Outline
Liquid crystals change their characteristics such as dielectric constant, magnetic constant, viscosity and elasticity, based on the alignment of rodlike molecules. Liquid crystal displays are an example of successful project which apply the nature of liquid crystals to the field of optics. We started research on liquid crystals from the mechanical point of view. Recently we succeeded in developing a principle which played a major role in creating a next generation mechanical system. If this principle can be applied, it will be possible to create actuators and motors. Since liquid crystals behave like a liquid, such the devices can easily be reduced in size and fitted to any shape. Emergence of the micro and flexible actuators would accelerate the development of microrobots, micromachines, medical robots, and high technology medical equipment in the next generation. We will predict the unsteady behaviors of the director and backflows induced by rotation of the director using the Leslie-Ericksen continuum theory. Furthermore, we will visualize the backflows to confirm the simulation results.

References
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