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光渦によるナノ粒子流の動的制御とその応用

Dynamical control of nanoparticle flow by optical vortex and its applications

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Nanofluidics 技術, すなわち, MEMS 加工技術と荷電微粒子の動的流動制御法に, ナノ電極より得られる時空間電流信号の AI 解析を融合して, 花粉アレルギーやウイルス検出・識別, さらには, 電気的 DNA シークエンシングの高速化を目指している¹⁻¹³. ここでは, ナノスケールのダブルスリットを作製し, 直径 $O(100)\text{nm}$ の各種ナノ粒子に対し, 光渦による光圧操作を行うことで, ナノスリットを周期的に通過する公転運動を実現し, そのイオン電流信号検出に成功した. また, 光渦による粒子公転運動の高速化手段として, 粒子同士の流体力学的相互作用を検討した. Oseen テンソルを用いた数値モデルによるシミュレーションは実験結果と良好な一致を示した.

文 献

- (1) C. Hosokawa, T. Tsuji, T. Kishimoto, T. Okubo, S. Kudoh, and S. Kawano, Convection dynamics forced by optical trapping with a focused laser beam, **J. Phys. Chem. C** 124 (2020), 8323-8333.
- (2) K. Doi, N. Asano, and S. Kawano, Development of glass micro-electrodes for local electric field, electrical conductivity, and pH measurements, **Sci. Rep.** 10 (2020), 4110 1-12.
- (3) T. Tsuji, R. Nakatsuka, K. Nakajima, K. Doi, and S. Kawano, Effect of hydrodynamic inter-particle interaction on the orbital motion of dielectric nanoparticles driven by an optical vortex, **Nanoscale** 12(2020), 6673-6690.
- (4) R. Nakamura, H. Kawaguchi, M. Iwata, A. Kaneko, R. Nagura, S. Kawano, K. Toyoda, K. Miyamoto, and T. Omatsu, Optical vortex-induced forward mass transfer: manifestation of helical trajectory of optical vortex, **Opt. Express** 27 (2019), 38019-38027.
- (5) T. Tsuji, Y. Matsumoto, and S. Kawano, Flow with nanoparticle clustering controlled by optical forces in quartz glass nanoslits, **Microfluid. Nanofluid.** 23 (2019), 126 1-11.
- (6) K. Setoura, T. Tsuji, S. Ito, S. Kawano, and H. Miyasaka, Opto-thermophoretic separation and trapping of plasmonic nanoparticles, **Nanoscale** 11 (2019), 21093-21102.
- (7) T. Tsuji, Y. Imada, H. Yamazaki, and S. Kawano, Simultaneous measurement of the oscillation characteristics and electrical voltage output of an artificial cochlear sensory epithelium immersed in a liquid: theory and experiment, **Sens. Actuators A Phys.** 295 (2019), 414-427.
- (8) T. Tsuji, Y. Matsumoto, R. Kugimiya, K. Doi, and S. Kawano, Separation of nano- and microparticle flows using thermophoresis in branched microfluidic channels, **Micromachines** 10 (2019), 321 1-16.
- (9) T. Tsuji, K. Doi, and S. Kawano, Modeling of single-particle translocation through a low-aspect-ratio nanopore, **J. Biomech. Sci. Eng.** 14 (2019), 18-00539 1-10.
- (10) R. Nagura, T. Tsujimura, T. Tsuji, K. Doi, and S. Kawano, Coarse-grained particle dynamics along helical orbit by an optical vortex irradiated in photocurable resins, **OSA Continuum** 2 (2019), 400-415.
- (11) T. Tsuji, Y. Sasai, and S. Kawano, Thermophoretic manipulation of micro- and nanoparticle flow through a sudden contraction in a microchannel with near-infrared laser irradiation, **Phys. Rev. Appl.** 10 (2018), 044005 1-18.
- (12) F. Nito, T. Shiozaki, R. Nagura, T. Tsuji, K. Doi, C. Hosokawa, and S. Kawano, Quantitative evaluation of optical forces by single particle tracking in slit-like microfluidic channels, **J. Phys. Chem. C** 122 (2018), 17963-17975.
- (13) K. Doi, F. Nito, A. Yano, R. Nagura, and S. Kawano, Generation and control of electrohydrodynamic flows in aqueous electrolyte solutions, **J. Vis. Exp.** 139 (2018) e57820 1-10.