

Research Papers on 'Biotechnology'

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Paper 1:

Novel approach for non-invasive phase-sensitive 2D imaging of biological objects with photovoltaic trapping

Date: 2025-02-26

Time: 10:06:31

Authors:

Lusine Tsarukyan, Anahit Badalyan, Rafael Drampyan

Summary:

- A novel non-invasive microscopy technique for imaging and sizing of folded DNA molecules with the use of photovoltaic tweezers and phase-sensitive detection is elaborated and realized. This novel method is compared with the state-of-the-art method of visualization of DNA molecules by fluorescent microscopy technique which requires the labeling of the DNA by dye molecules. The advantage of the novel method is no requirement for the incubation of DNA with a fluorescent label, as well as the simultaneous observation of the light-induced inside the crystal refractive lattice (i.e. photovoltaic field configuration) and the trapped micro-objects by the phase-contrast method. The suggested novel method provides the accurate measurement of the size and shape of the folded DNA molecules as well as the determination of the charged or neutral nature of the trapped bio-objects by their disposition relative to the lattice fringes. We demonstrate that the labeling of DNA causes an overestimation of the molecular size. The method can be extended to the other bio-objects. The high-performance photovoltaic tweezers operating in an autonomous regime as lab-on-a-chip devices are promising for applications in integrated optics, microscopy, micro- and nanoelectronics, and biotechnology.

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Paper 2:

Thiolation and PEGylation of silicon carbide nanoparticle

Date: 2025-02-12

Time: 15:03:35

Authors:

Péter Rózsa, Olga Krafcsik, Zsolt Czigány, Sándor Lenk, David Beke, Adam Gali

Summary:

- In this study, we implement thiol termination on the surface of few-nanometer-sized silicon carbide (SiC) nanoparticles (NPs) to enable further applications, such as fluorescent biomarkers. Various spectroscopic techniques are employed to monitor the effectiveness of the surface treatment. Additionally, a thiol-Michael addition reaction is performed by conjugating 4-arm PEG-maleimide molecules to the thiol groups of SiC NPs, further demonstrating the reactivity of thiol-terminated SiC NPs. These thiolated SiC NPs, both with and without conjugated molecules, open new avenues in biotechnology.

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Paper 3:

FoodMem: Near Real-time and Precise Food Video Segmentation

Date: 2025-02-10

Time: 12:26:06

Authors:

Ahmad AlMughrabi, Adrián Galán, Ricardo Marques, Petia Radeva

Summary:

- Food segmentation, including in videos, is vital for addressing real-world health, agriculture, and food biotechnology issues. Current limitations lead to inaccurate nutritional analysis, inefficient crop management, and suboptimal food processing, impacting food security and public health. Improving segmentation techniques can enhance dietary assessments, agricultural productivity, and the food production process. This study introduces the development of a robust framework for high-quality, near-real-time segmentation and tracking of food items in videos, using minimal hardware resources. We present FoodMem, a novel framework designed to segment food items from video sequences of 360-degree unbounded scenes. FoodMem can consistently generate masks of food portions in a video sequence, overcoming the limitations of existing semantic segmentation models, such as flickering and prohibitive inference speeds in video processing contexts. To address these issues, FoodMem leverages a two-phase solution: a transformer segmentation phase to create initial segmentation masks and a memory-based tracking phase to monitor food masks in complex scenes. Our framework outperforms current state-of-the-art food segmentation models, yielding superior performance across

various conditions, such as camera angles, lighting, reflections, scene complexity, and food diversity. This results in reduced segmentation noise, elimination of artifacts, and completion of missing segments. Here, we also introduce a new annotated food dataset encompassing challenging scenarios absent in previous benchmarks. Extensive experiments conducted on MetaFood3D, Nutrition5k, and Vegetables & Fruits datasets demonstrate that FoodMem enhances the state-of-the-art by 2.5% mean average precision in food video segmentation and is 58 x faster on average.

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Paper 4:

Simulation of the thermocapillary assembly of a colloidal cluster during the evaporation of a liquid film in an unevenly heated cell

Date: 2025-02-10

Time: 06:37:57

Authors:

Kristina N. Kondrashova, Konstantin S. Kolegov, Irina V. Vodolazskaya

Summary:

- The control of the thermocapillary assembly of colloidal particle clusters is important for a variety of applications, including the creation of photonic crystals for microelectronics and optoelectronics, membrane formation for biotechnology, and surface cleaning for laboratory-on-chip devices. It is important to understand the main mechanisms that influence the formation of such clusters. This article considers a two-dimensional mathematical model describing the transfer of particles by a thermocapillary flow in an unevenly heated cell during the evaporation of a liquid. This gave us the opportunity to study one of the main processes that triggers the formation of a particle cluster. Whether the particle will move with the flow or stop at the heater, becoming the basis for the cluster, is determined by the ratio between gravity and the drag force. The results of numerical calculations show that, for small particle concentrations, their fraction entering the cluster decreases as the volumetric heat flux density Q increases. The reason for this is an increase in the thermocapillary flow with an increase in the volumetric heat flux Q . It reduces the probability of particles entering the cluster.

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