AI-ASSISTED RECOGNITION AND KINETIC DATA EXTRACTION FROM IN SITU MICROSCOPY VIDEOS OF CARBON NANOTUBE GROWTH

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IN COOPERATION WITH : Laboratoire Charles Coulombe, Univ Montpellier

LEVEL : M2
TEAM(S) : PNEC

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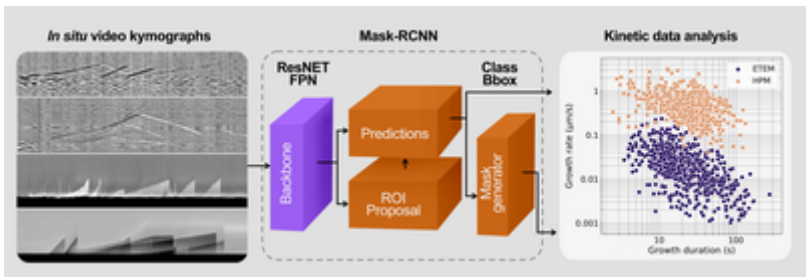
KEYWORD(S) : In situ microscopy videos / Carbon nanotubes growth kinetic / Computer vision

SCIENTIFIC CONTEXT :



Schema of the project

Automating the recognition and tracking of individual objects in microscopy videos is key to enabling high-throughput analysis of nanoscale phenomena. Carbon nanotubes (CNTs), with their exceptional electronic and optical properties, are promising materials for next-generation devices, yet understanding how their growth selectivity and structural evolution depend on synthesis conditions remains a challenge. In situ microscopy provides direct access to CNT growth kinetics, but the large volume and complexity of the recorded videos make manual analysis inefficient and hinder statistical studies.

This project aims to develop an AI-assisted system for automated recognition and kinetic data extraction from in situ videos of CNT growth acquired by homodyne polarization microscopy (HPM)[1] and environmental transmission electron microscopy (ETEM)[2]. Based on deep-learning architectures (Mask R-CNN, ResNet) [3], the system will detect CNT growth traces in kymographs and extract parameters such as growth rate, lifetime, and nucleation time. The goal is to design a universal, cross-modality framework applicable to both imaging techniques. The intern will contribute to dataset preparation, model training and validation, and data analysis, with the possibility to participate in in situ growth experiments depending on background and interest.

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MISSIONS :

The intern will:

· Develop and implement a deep-learning pipeline (Mask R-CNN with ResNet backbones) for kymograph recognition and kinetic curve tracking.

· Prepare and annotate datasets, train models on both artificial and experimental data, and evaluate robustness across noisy/contrasted videos.

· Apply the trained models to large datasets from ETEM and HPM videos to extract statistical growth information.

Techniques & methods:

· Programming: Python, PyTorch, numpy, pandas, matplotlib

· Deep learning: Mask R-CNN, ResNet (18–50), dataset generation & model training

· Microscopy & data processing: ETEM imaging, optical HPM, kymograph analysis

OUTLOOKS :

The project can be extended into a PhD thesis, supported by doctoral school

BIBLIOGRAPHY :

[1] Pimonov, V. et al., *Nano Lett.* 21, 8495–8502 (**2021**).

[2] Vincent, P. et al., *Carbon* 213, 118272 (**2023**).

[3] Pimonov, V., Tahir, S. & Jourdain, V., *Beilstein J. Nanotechnol.* 16, 1316–1324 (**2025**).

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