FLIM Guided Nanomedicine: PLGA Nanoparticles for Controlled Baricitinib Delivery

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Background

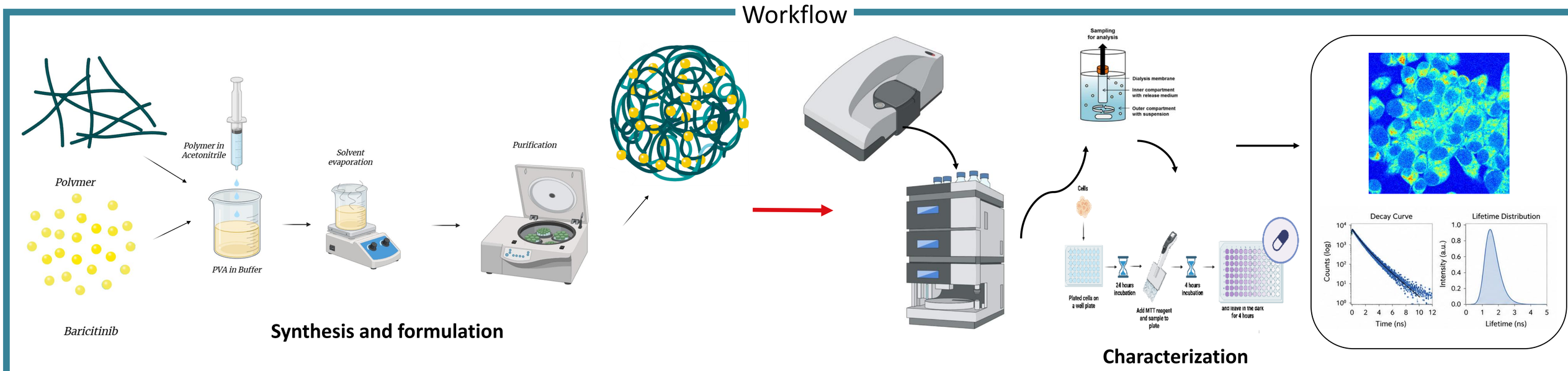
Fluorescence Lifetime Imaging Microscopy (FLIM) is a powerful technique for investigating the supramolecular organization and local microenvironment of fluorescent molecules. Because fluorescence lifetime is highly sensitive to molecular interactions and environmental conditions, FLIM can provide structural and compositional information that is often inaccessible through conventional intensity-based measurements. Combined with phasor analysis, FLIM enables fit-free visualization of distinct fluorescent populations within complex nanostructured systems, making it a valuable tool for nanomedicine characterization.

Baricitinib (Bar), a selective JAK1/2 inhibitor, was encapsulated into biodegradable poly(lactic-co-glycolic acid) (PLGA) nanoparticles to improve drug delivery and achieve controlled release. However, conventional analytical techniques provide limited information on drug organization within nanocarriers. In this context, FLIM offers a non-invasive and label-free approach to distinguish free from encapsulated drug and investigate nanoparticle composition.

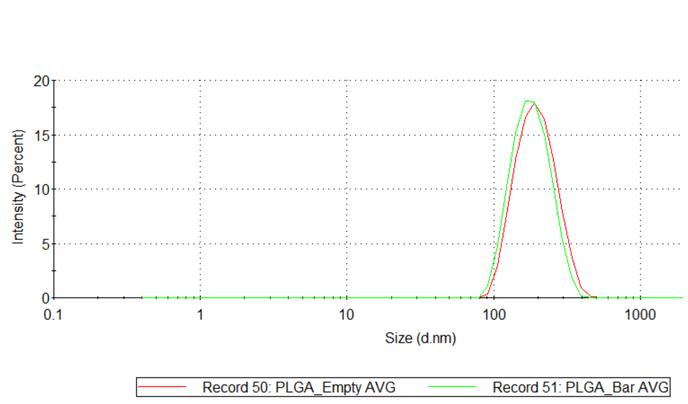
Aim of the study

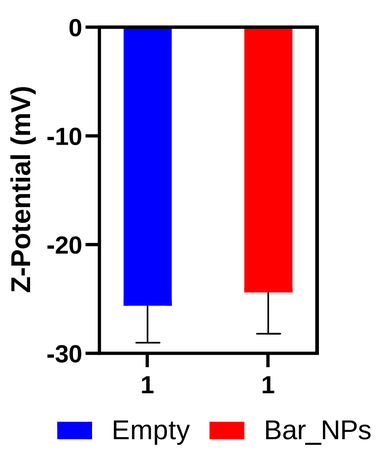
Evaluation of the potential of FLIM-phasor analysis as a non-invasive and label-free tool for the characterization of drug-loaded polymeric nanoparticles, using Baricitinib-loaded PLGA nanoparticels as a model system.

Workflow



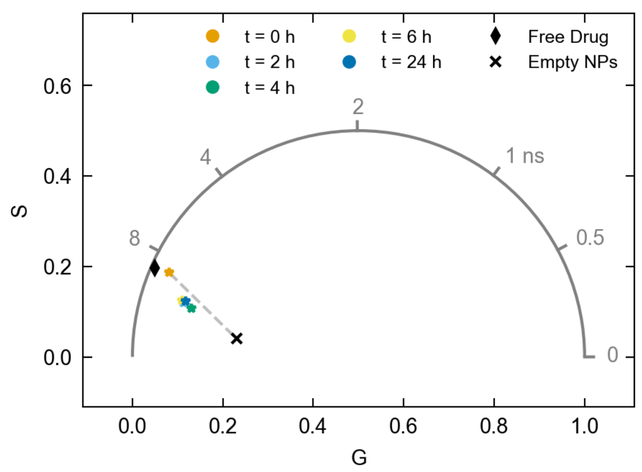
Results

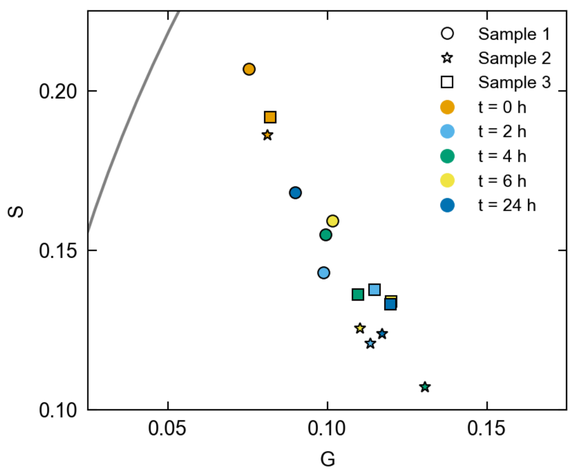




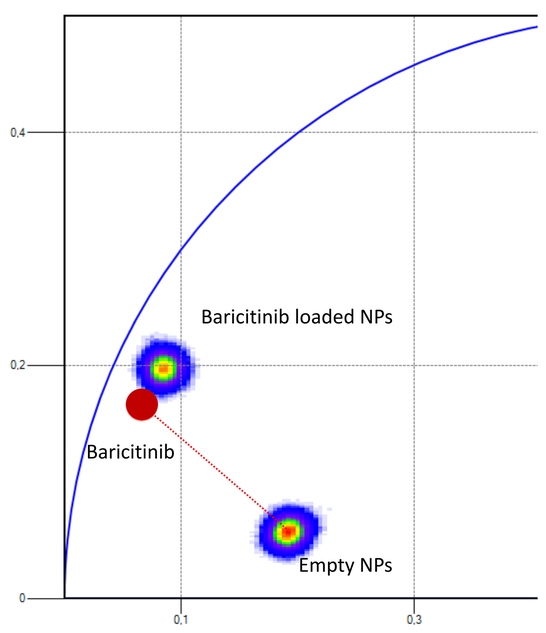
	Size (nm) ± SD	PDI ± SD
Empty NPs	184,2 ± 3,1	0,08 ±0,02
Bar NPs	171,5 ± 2,7	0,07 ±0,02

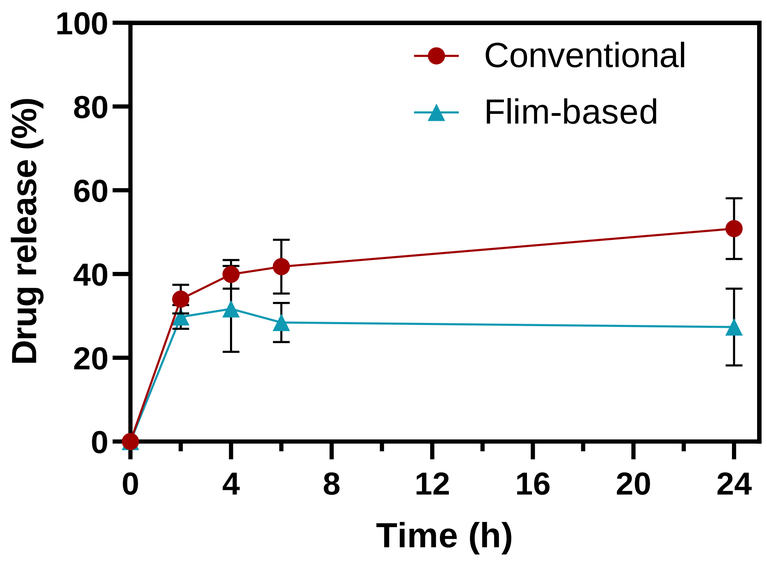
Conventional Nanomedicine Characterization

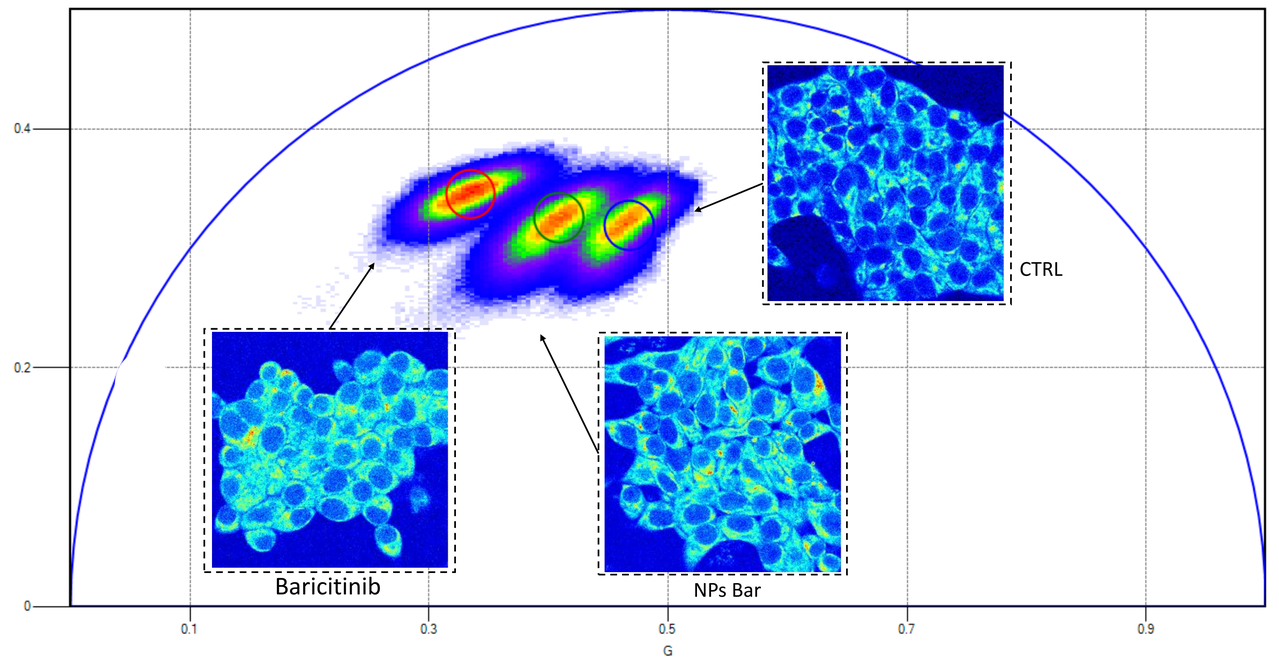




FLIM Characterization







Conclusion and future prospective

FLIM proved to be a valuable tool for the characterization of Baricitinib-loaded PLGA nanoparticles, providing insights into drug encapsulation, nanoparticle composition, and intracellular drug fate. These findings support the use of FLIM-phasor analysis as a non-invasive and label-free approach for nanomedicine characterization and motivate its further development for the study of complex drug delivery systems and in vivo applications.

Acnowledgment

The activity was carried out within the project: enLIGHT "Label-free fluorescence lifetime analysis for the screening of nanoencapsulated drugs", Grant Agreement 101247526, CUP E53C25001750006.