

Raman spectroscopy characterization of multifunctional nanoliposomes for neurological disorders

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Drug delivery to the brain is still challenging because of the presence of the blood-brain barrier (BBB), which limits drugs' access to the brain.

Liposomes (LPs) have been proposed for their therapeutic potential that can improve the brain bioavailability of drugs, thanks to their versatile composition and structure.

How LPs can be characterized?

Raman Spectroscopy (RS) provides a specific spectrum with peaks related to the biochemical sample composition.

RS advantages:
 small sample amount & fast analysis

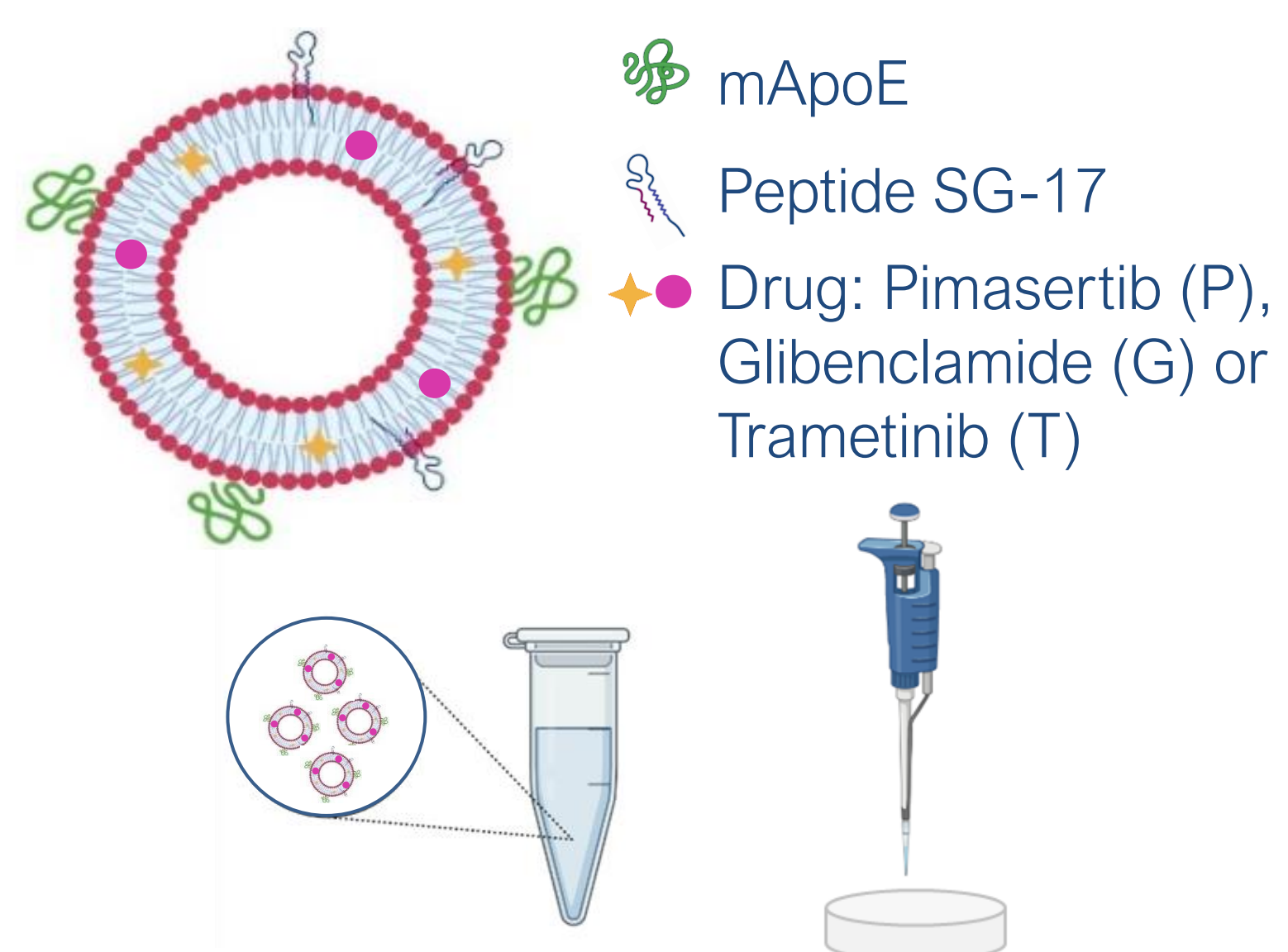
Aim of the study

We propose RS for the characterization of LPs to be tested for the control of neuroinflammation and microglial dysfunctions in Glioblastoma multiforme and Alzheimer's disease, in order to test:

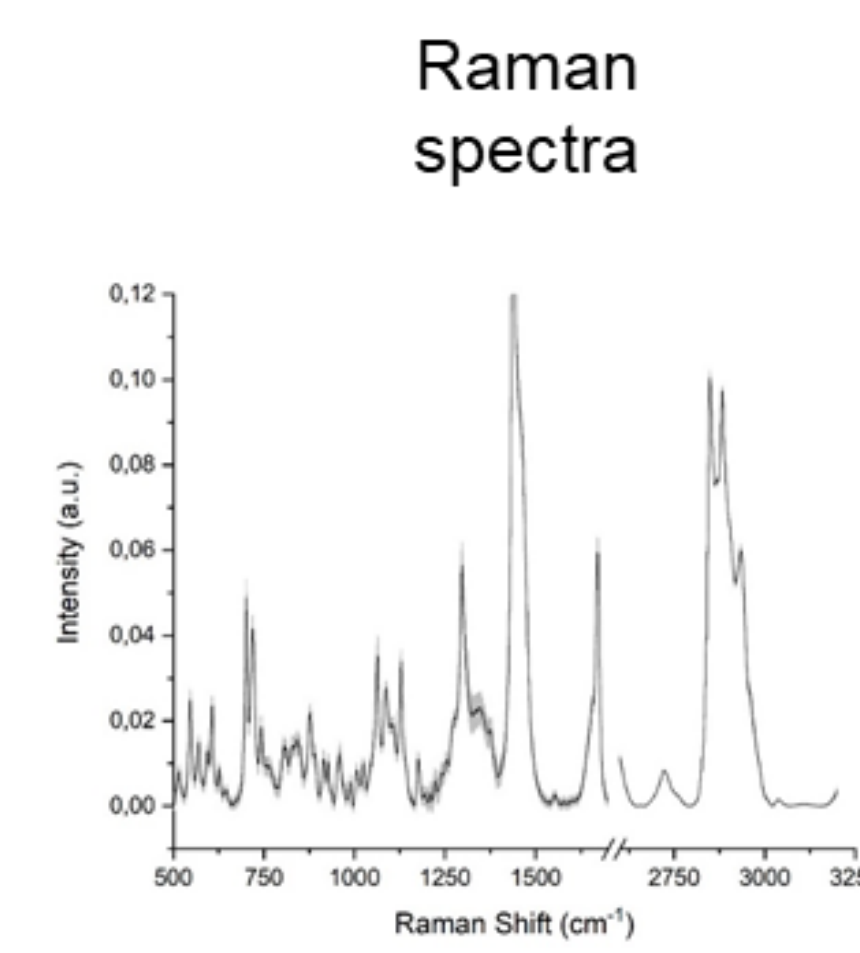
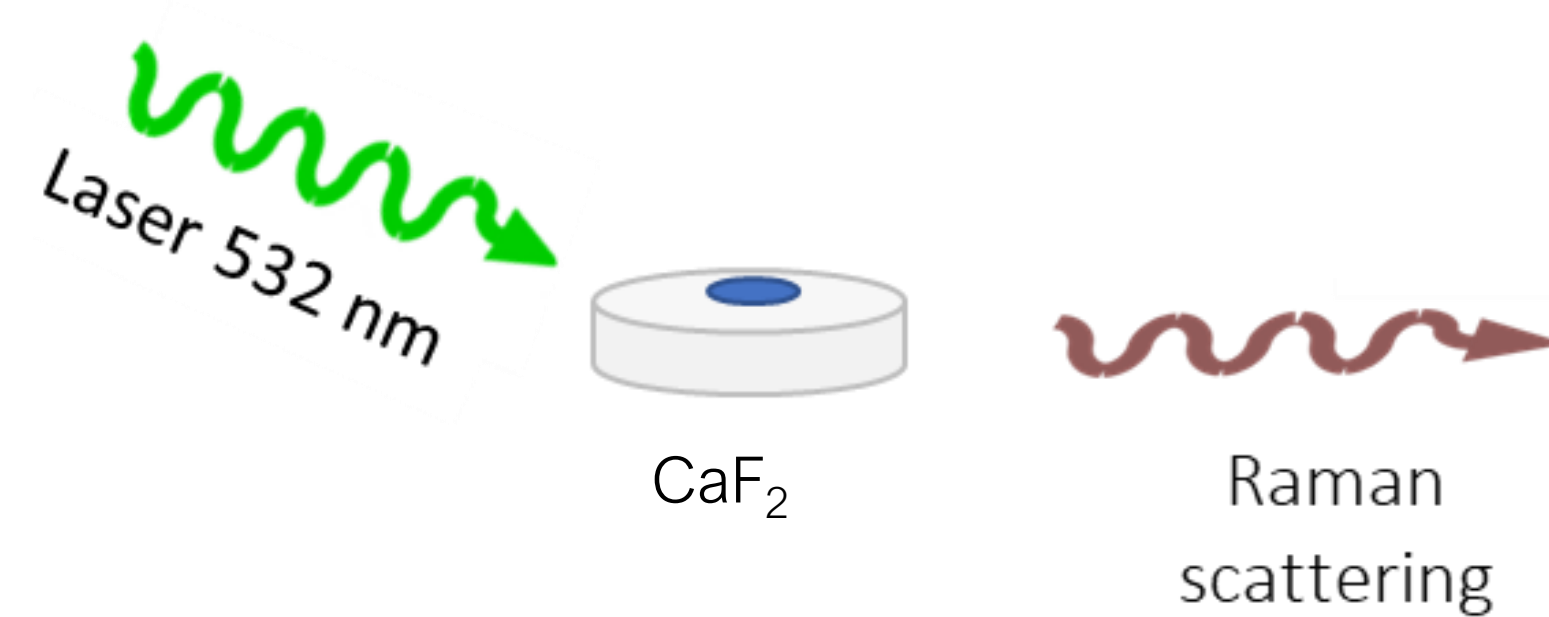
- their reproducibility
- the effective functionalization with selected ligands
- their stability

Methods

SAMPLE PREPARATION



RAMAN ANALYSIS



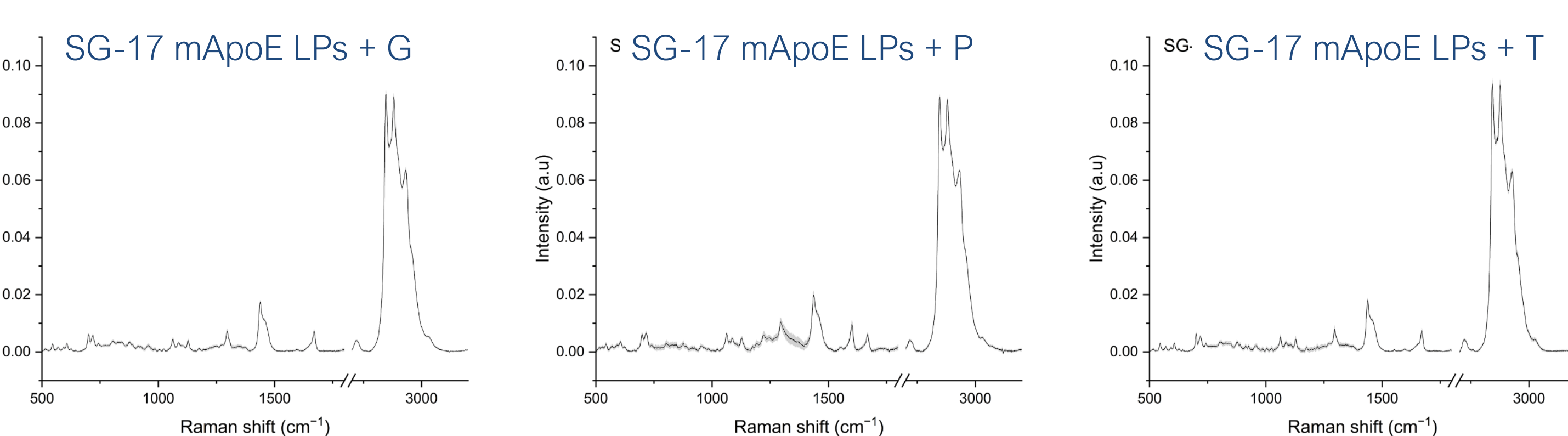
Raman acquisition/data analysis parameters

Drop volume	3 μl
Laser source	532 nm
Objective	100x
Spectral range	500–1800 cm ⁻¹ 2700–3200 cm ⁻¹
Acquisition time	25s x 2 accumulations
Diffraction grating	1800 grooves/mm
Entrance slit	200 μm
Hole	400 μm
Number of spectra	15-20 spectra per drop
Post-processing	Polynomial baseline subtraction and unit vector normalization

Results

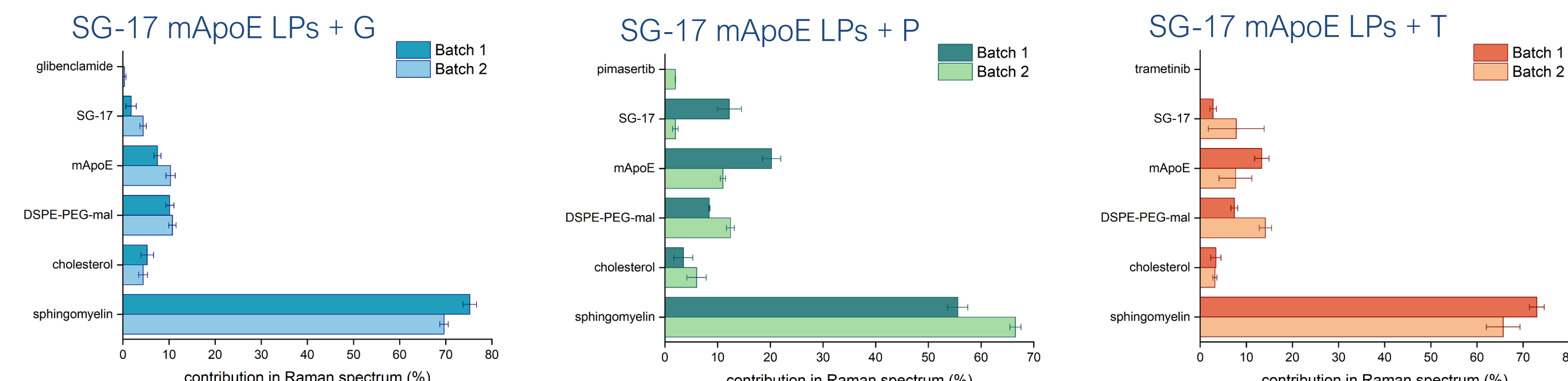
Ref: Rodà F et al. 2023 Nanomaterials.

LPs RAMAN SPECTRA



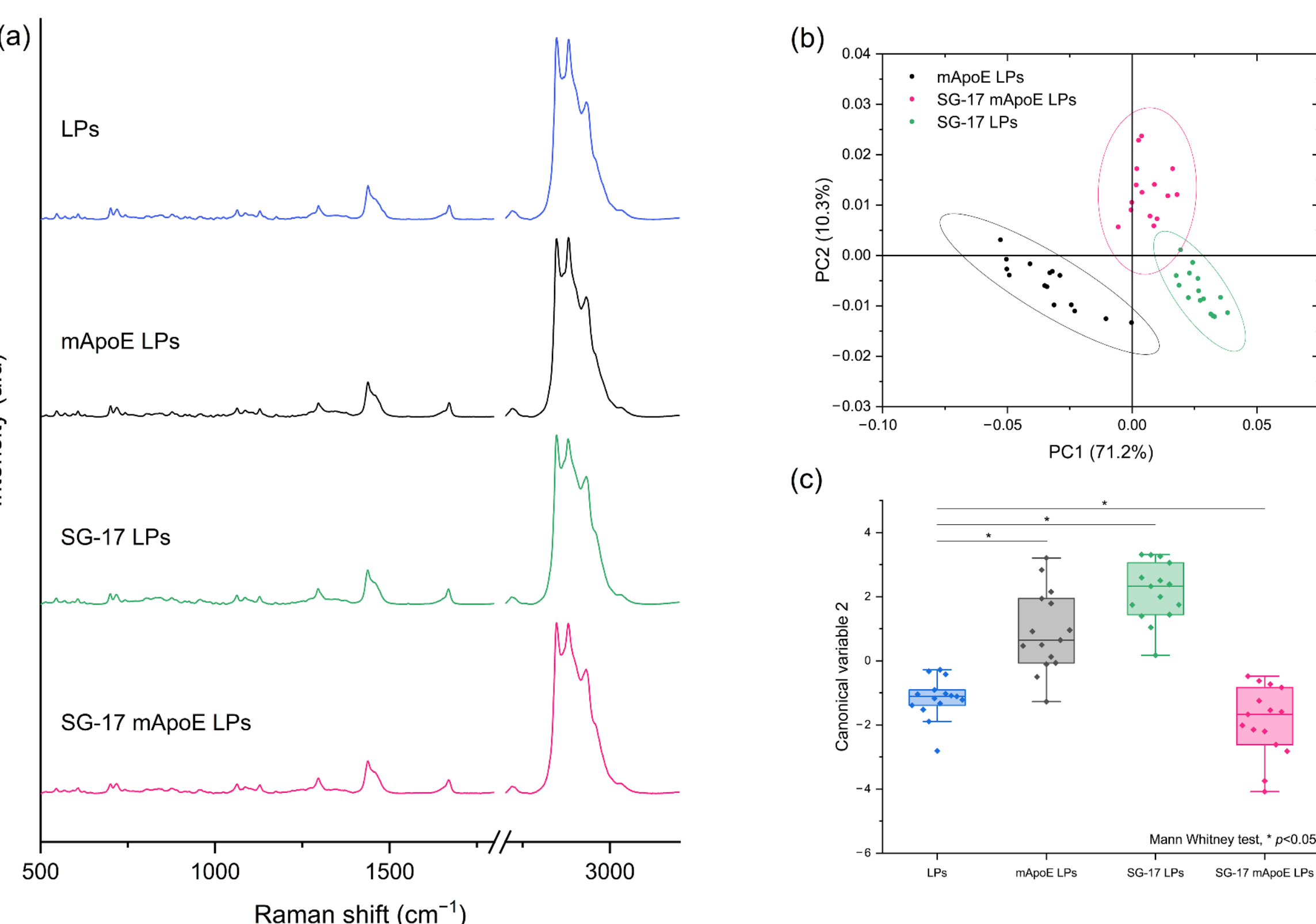
LP Raman spectra are a combination of the signals of single components, with prominent peaks confirming their composition

REPRODUCIBILITY OF LP SYNTHESIS



CLS analysis revealed a good level of synthetic reproducibility, showing <14% variations in the contribution of each component in the Raman spectrum of the same LP

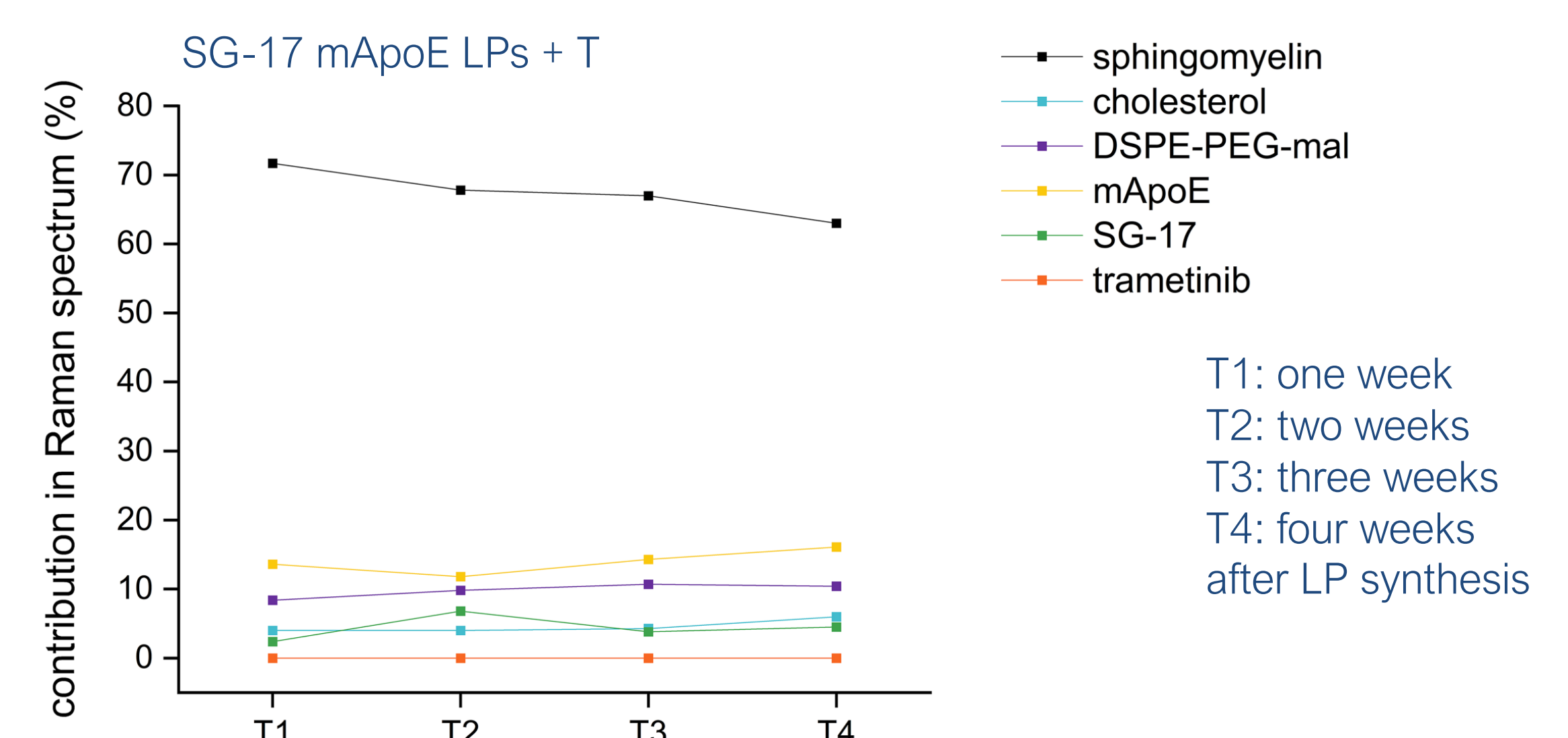
DISCRIMINATION OF LPs WITH DIFFERENT FUNCTIONALIZATION PATTERNS



Each molecular component has an influence in the Raman spectrum of the final LP formulation

RS is able to differentiate the differently functionalized LP formulations

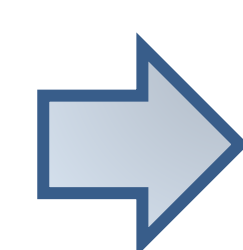
STABILITY OF LPs WITH TRAMETINIB



The variability is < 5% between subsequent weeks and < 9% within 1 month from the synthesis, confirming the stability of these formulations for at least 1 month

Conclusions

RS represents a valuable tool for a fast, sensitive and label free biochemical characterization of LPs that could be used for quality control of nanoparticle-based therapeutics



This innovation in the characterization of LP-based drug-delivery systems can be extended to different types of nanoparticles for the treatment of many diseases

