

Influence of the various conductive polymer matrices on the structural and optical properties of Alq₃ layers

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INTRODUCTION

We investigated the structural and optical properties of the thin films of tris(8-hydroxyquinoline)aluminum (Alq₃) dispersed in conductive polymers matrices such as poly(9-vinylcarbazole) (PVK), polystyrene sulfonate (PSS) and poly(3-octylthiophene-2,5-diyl) (P3OT).

Alq₃ is one of the most important metalloorganic compound used in organic light-emitting diodes (OLEDs) as an electron-transport material and emitting layer. Alq₃ is a highly efficient emitting material of green light. In Alq₃, the light emission originates from the ligand's electronic π - π^* transition from the highest occupied molecular orbital (HOMO) to the lowest unoccupied molecular orbital (LUMO). Alq₃ also serves as the parent material for various dyes to fine-tune the emission color from green to red [1-3].

The structural and optical properties of the Alq₃:polymer thin films prepared by a spin-coating method were analyzed using UV-Vis and IR spectroscopies, photoluminescence (PL) as well as optical confocal microscopy.

SAMPLE PREPARATION

Fig. 1 presents the molecular structure of Alq₃ that belongs to a class of metal chelates, in which the central metal ion Al³⁺ is surrounded by three ligands (8-hydroxyquinoline anions).

PVK, PSS and P3OT powders were dissolved in tetrahydrofuran. Then, Alq₃ powder was added to the dissolved polymers at concentration of 10 wt%. The prepared solution was coated on to the cleaned quartz and silicon substrates using the spin-coating method.

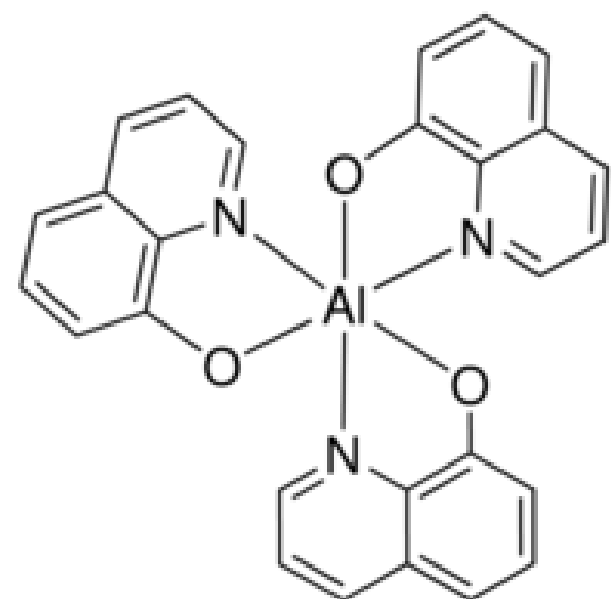
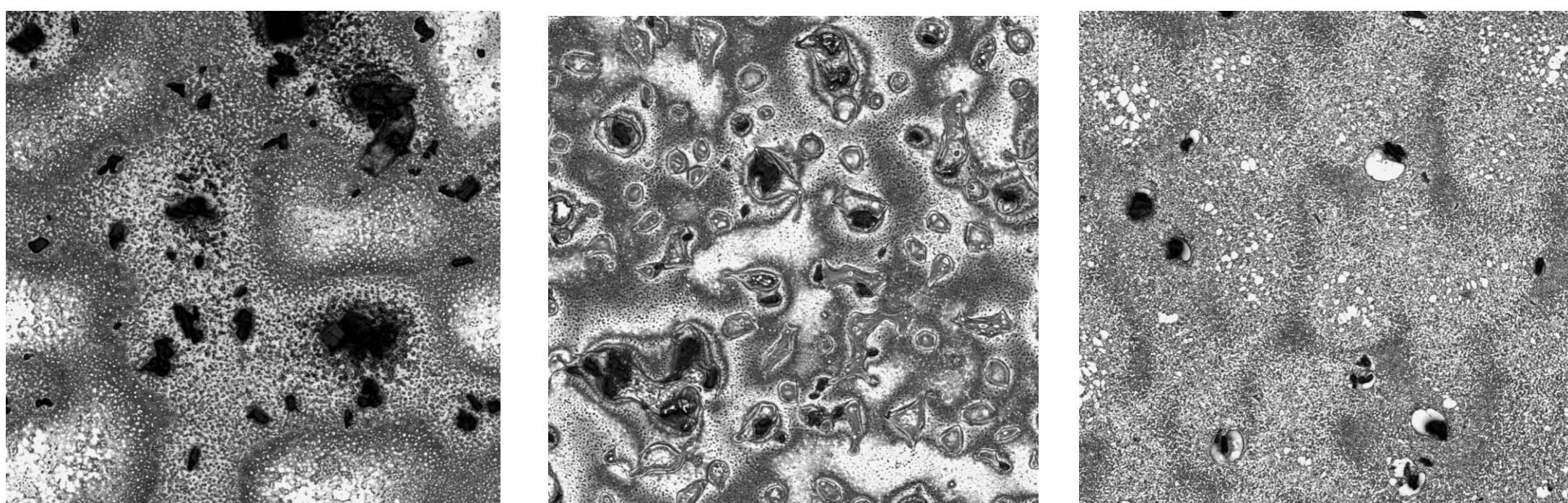


Fig. 1. Alq₃ structure
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STRUCTURAL PROPERTIES



Alq₃:P3OT

Alq₃:PSS

Alq₃:PVK

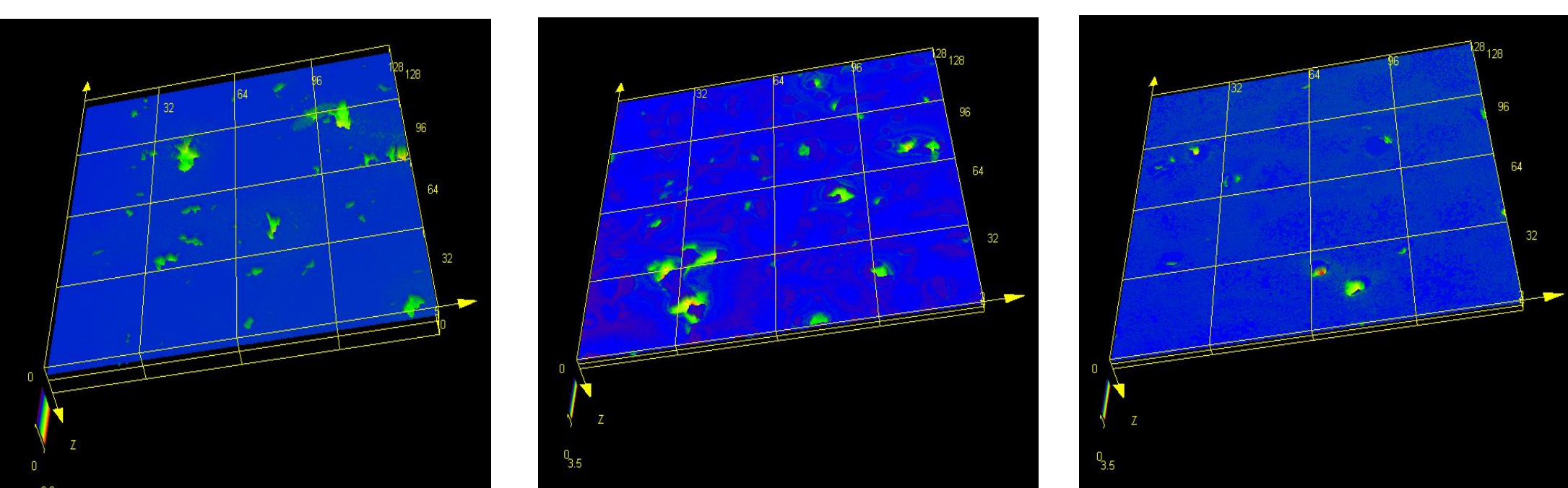


Fig. 2. 2D and 3D images from confocal microscopy for Alq₃:polymer thin films (x100).

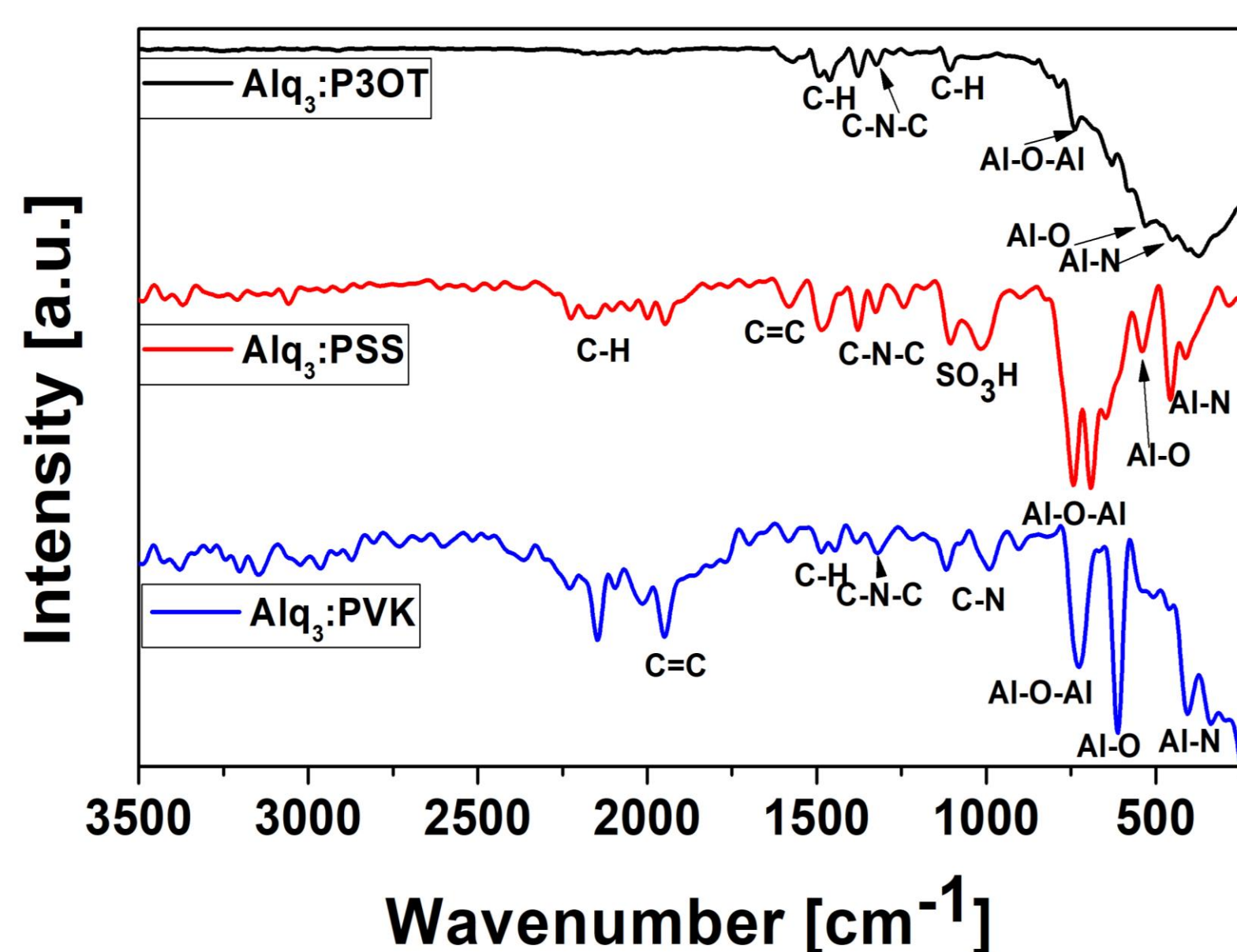


Fig. 3. FTIR spectra recorded for Alq₃:polymers thin films.

OPTICAL PROPERTIES

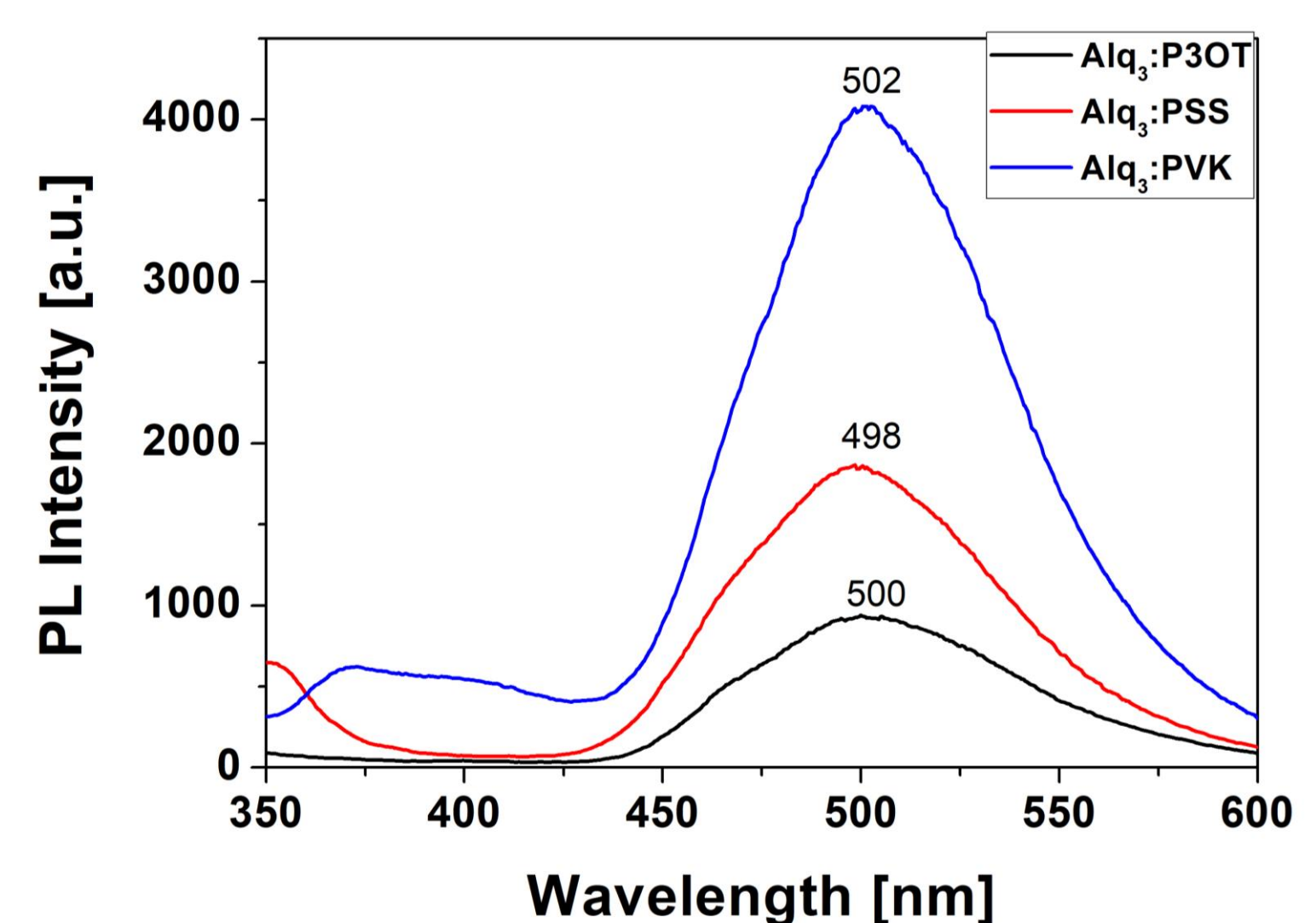


Fig. 4. Luminescence spectra of Alq₃:polymers thin films ($\lambda_{exc.} = 325$ nm, *R.T.*).

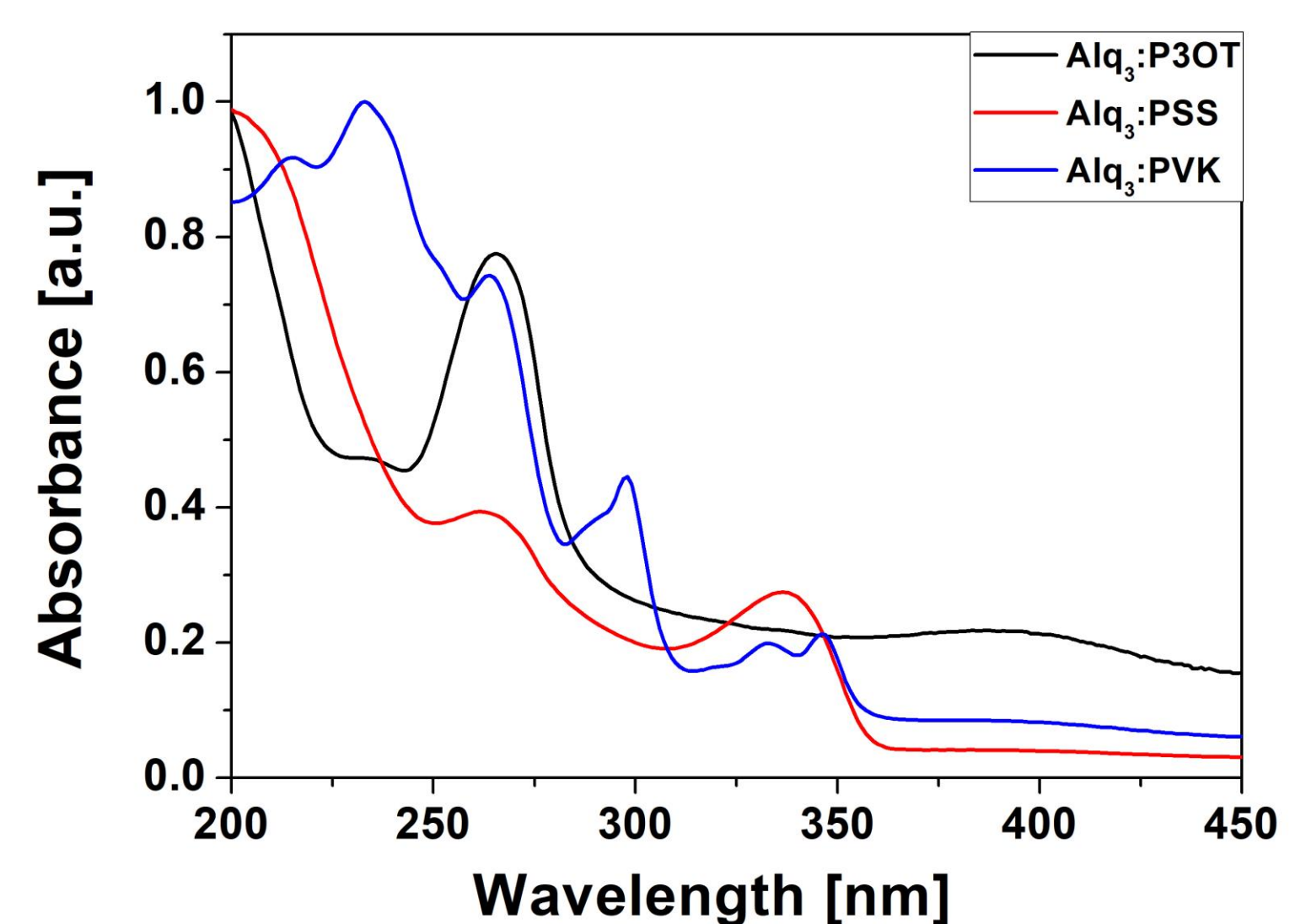


Fig. 5. Absorption spectra of Alq₃:polymers thin films.

SUMMARY

- The tris(8-hydroxyquinoline)aluminum layers dispersed in various conductive polymers were prepared using the spin-coating method.
- Confocal microscope images of the studied thin films show that they are relatively smooth.
- The characteristic bands for Alq₃ recorded in the FTIR spectrum are: Al-N in the 460 cm⁻¹ region, Al-O in ~620 cm⁻¹ and Al-O-Al in ~740 cm⁻¹.
- The PL spectrum of the studied layers shows a strong peak with a maximum of about 500 nm.
- Absorption spectra show characteristic bands for Alq₃, which are ligand centered electronic transitions.

[1] C.W. Tang, S.A. Van Slyke, C.H. Chen, *Electroluminescence of doped organic thin films*, J. Appl. Phys. 65, 3610-3616 (1989).
[2] J.G. Mahakhode, S.J. Dhoble, C.P. Joshi, S.V. Moharil, *Blue-shifted photoluminescence of Alq₃ dispersed in PMMA*, Bull. Mater. Sci. 34, 1649-1651 (2011).
[3] B. Derkowska-Zielinska, *Enhancement of third order nonlinear optical susceptibility of Alq₃ in polar aprotic solvents*, Opt. Lett. 42, 567-570 (2017).