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Silver Nanowire Electrodes and Plasmonic Resonance influences on PF2:PC70BM Organic Solar Cells

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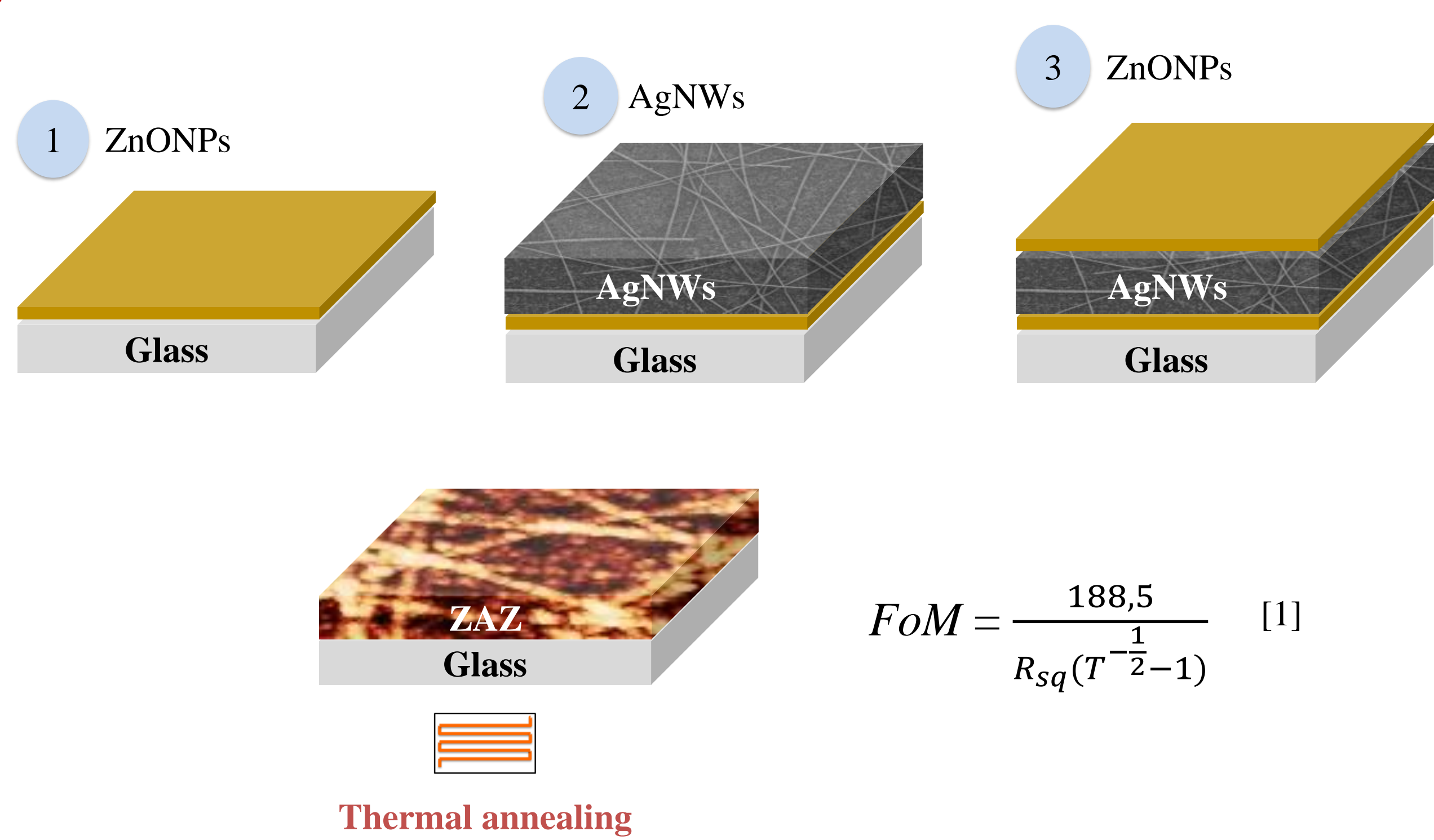


ICSM2022

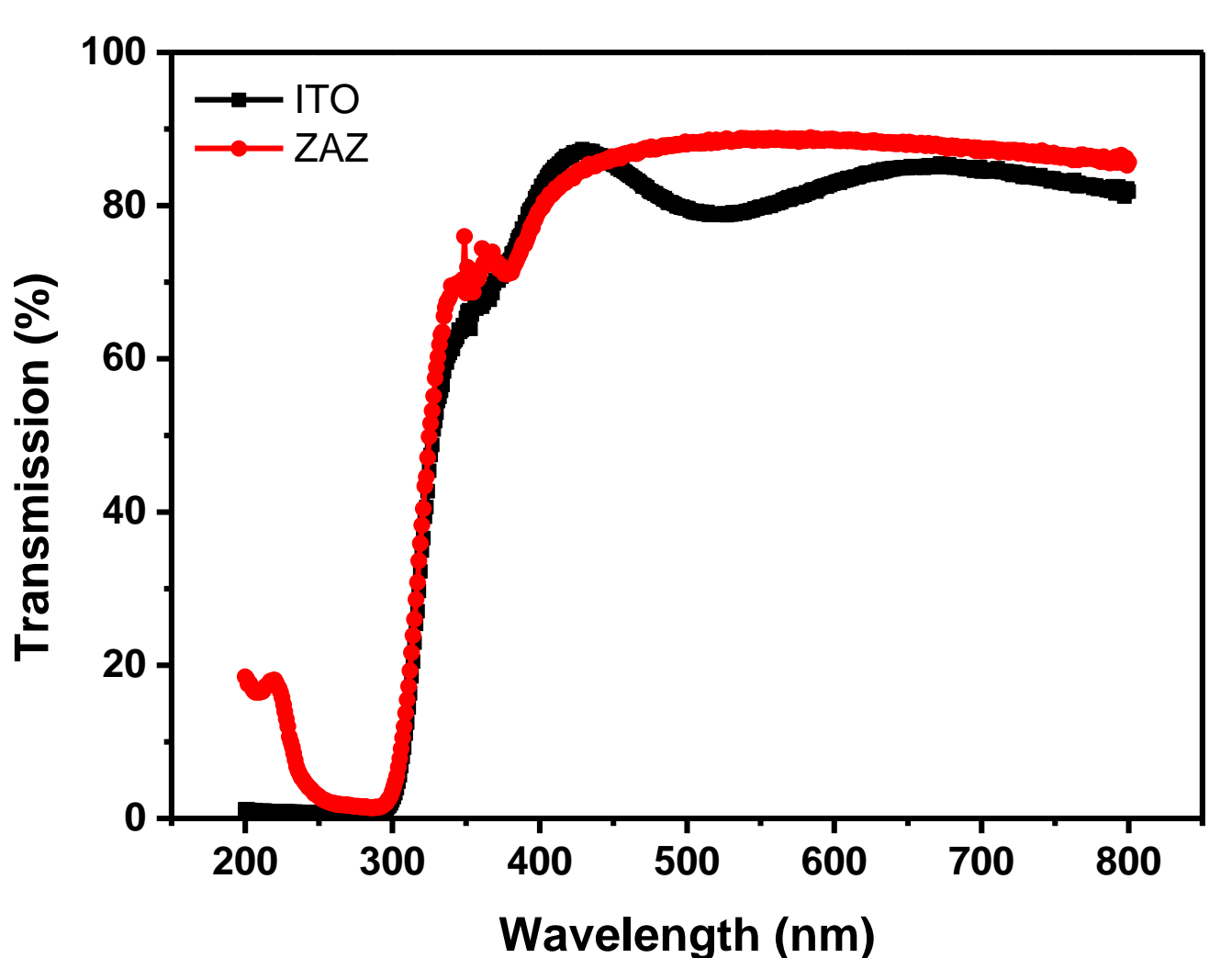
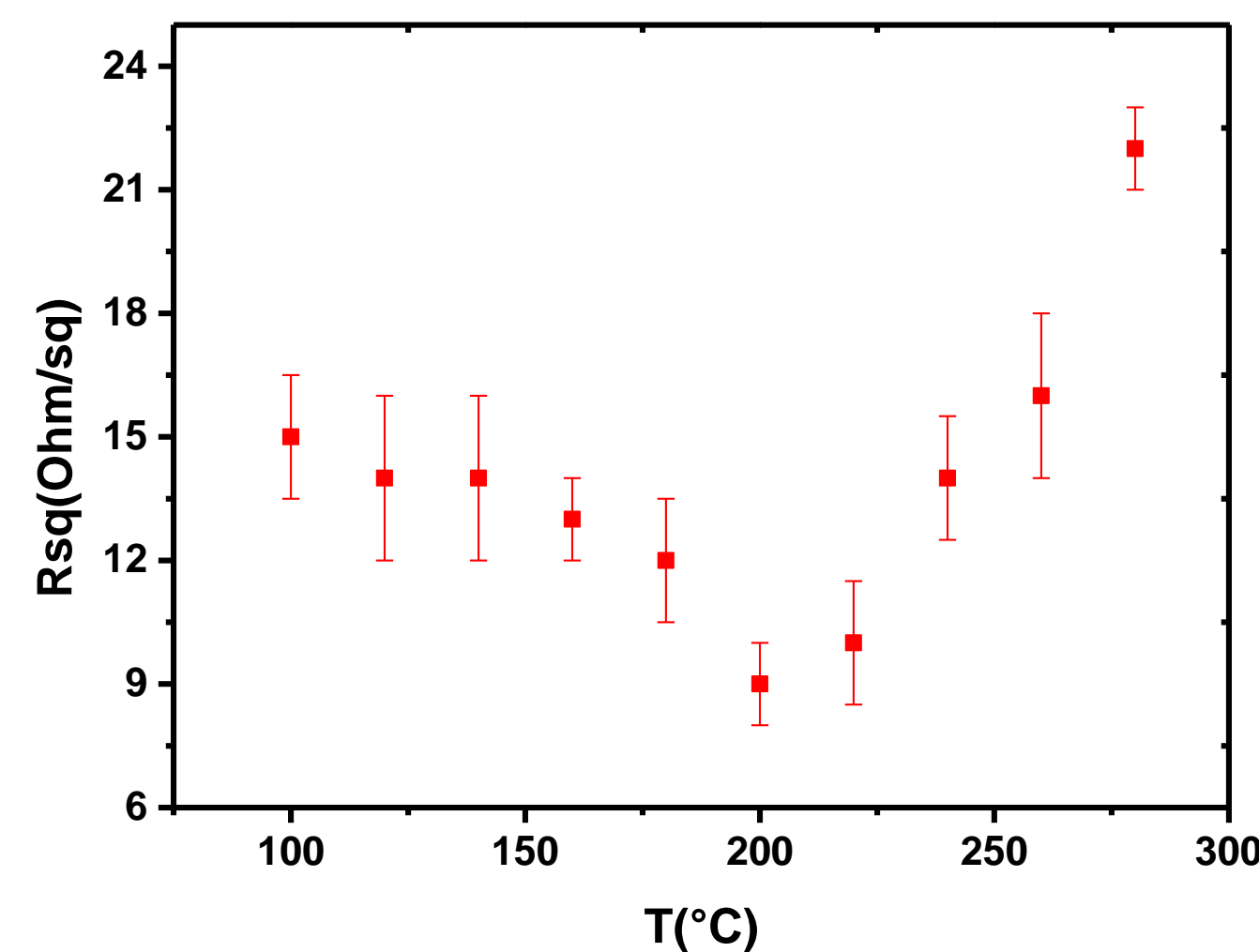
Abstract

The transparent electrode commonly used in organic solar cells is based on indium tin oxide (ITO). It contains indium, which is an expensive, rare, difficult to extract and depleting element, hence the need to find an alternative. Silver Nanowire (AgNW) electrodes are one of the best alternatives due to their excellent electrical, optical, and mechanical properties. In this work, we showed that embedding AgNWs between two layers of ZnO nanoparticles (ZnONPs) leads to superior optical and electrical performance. As a result, we achieved a figure of merit (FoM) of 278 for ZnONPs/AgNWs/ZnONPs (ZAZ) electrode compared to 254 for ITO one. We also highlighted the effect of plasmon resonance related to silver nanowires through FDTD numerical simulation. We observed increased absorption of the active layer of a PF2:PC70BM based organic solar cell. This enhancement is due to the electric field resulting from plasmonic resonance since the absorption is proportional to the square of the electric field amplitude. This phenomenon is followed by an increase in the performance of the solar cell from 6.08% Power Conversion Efficiency (PCE) with ITO to 8.13% with silver nanowire electrodes.

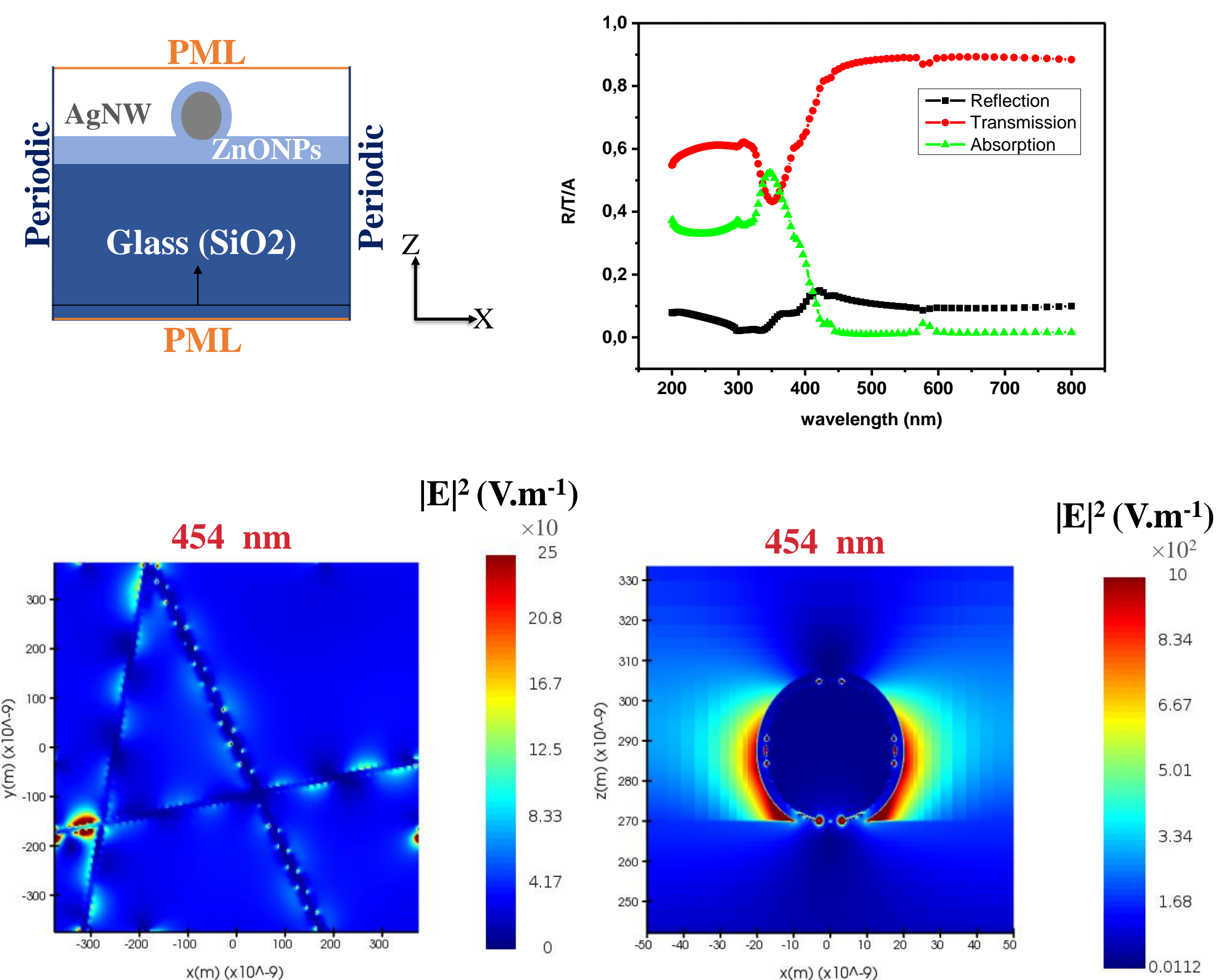
Deposition and optoelectronic properties



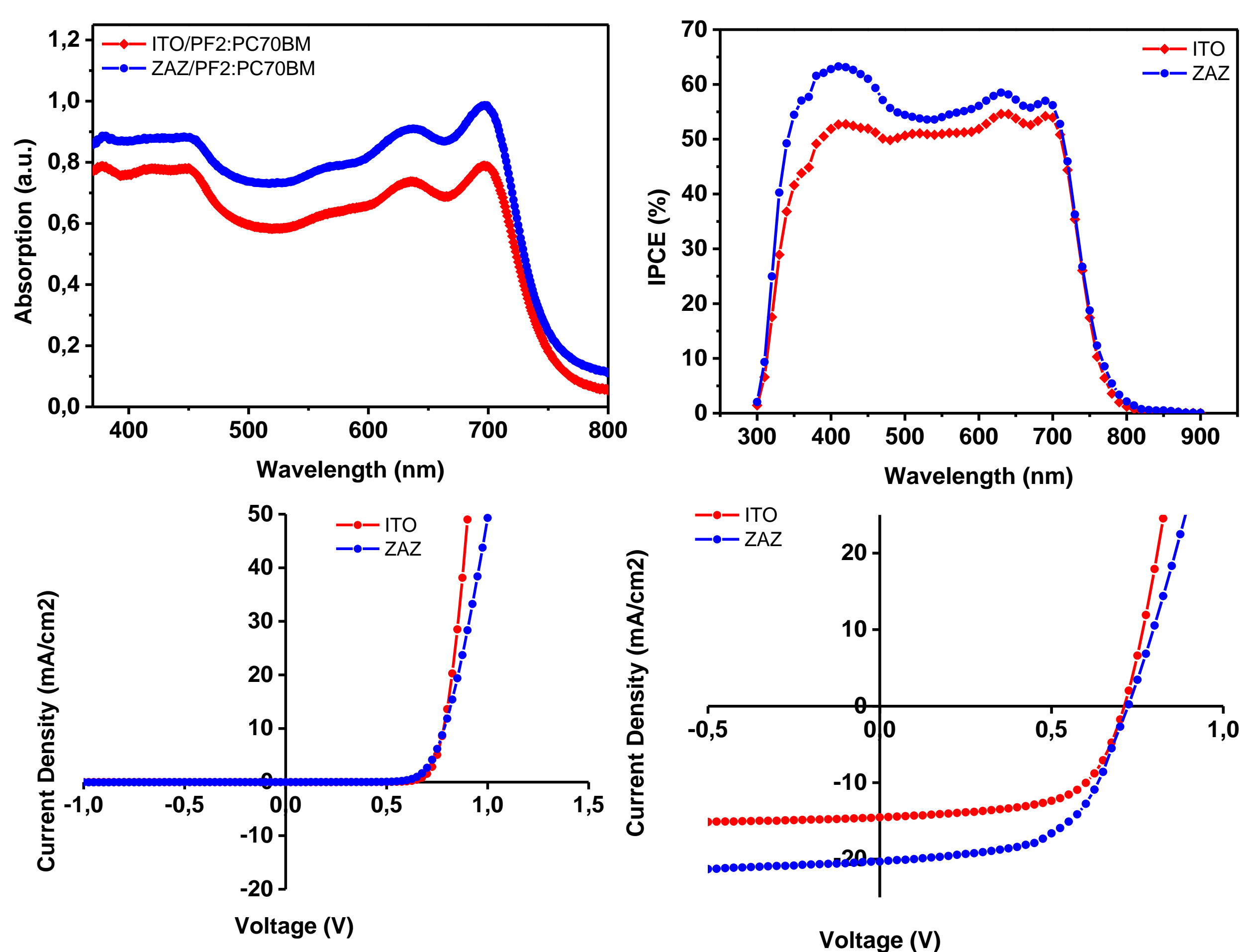
Sample	ZnO	AgNWs (RPM)	ZnO	R _{sq} (Ω/□)	T ₃₅₀₋₈₀₀ nm(%)	FoM	Annealing (°C/10min)
ZAZ	20 nm	2000	30 nm	9	86,5	278	200
ZAZ	20 nm	2000	60 nm	13	84,7	161	200
ZAZ	20 nm	2000	90 nm	24	82,4	77	200
ITO	-	-	-	7	81,7	254	-



FDTD Simulation



Preliminary Results of ZAZ into PF2:PC70BM Based OSC



Cathode	Voc(V)	Jsc(mA/cm2)	FF	η(%)	Rs (Ω)	Rsh (Ω)
ITO	0.687	14.51	0.61	6.08	28	1978
ZAZ	0.705	20.25	0.57	8.13	31	1433

Conclusion and Outlook

In this work we investigated AgNWs based electrode and we show that it is a promising alternative to ITO. It allows to improve transmission and conductivity of the related electrode. It is also low energy consuming process.

The plasmonic resonance related to AgNWs tends to improve the performance of the OSC. The efficiency increase from 6.08% with ITO to 8.13% with ZAZ. That is 33% PCE enhancement.

In future work, we plan to :

- Optimize the thickness of the active layer,
- Integrate ZAZ electrode in fullerene free organic solar cells
- Investigate furthermore the Plasmonic Resonance in OSCs

Reference

[1] S. De, T. M. Higgins, P. E. Lyons, E. M. Doherty, P. N. Nirmalraj, and W. J. Blau, "Boland J Jand Coleman J N," Silver nanowire networks as flexible, transparent, Conduct. Film. Extrem. high DC to Opt. Conduct. ratios, vol. 3, no. 7, pp. 1767-1774, 2009.

