**Heuristic approach to the fundamental optical constants of silver**

**nanowire networks: experiments and theory**

A. Baret1,\*, J. Baumgarten2 , F. Balty1, J. Brisbois3, F. Rabecki3, B. Zheng4,

D. Bellet4, N. D. Nguyen1

*1SPIN, Department of Physics, Université de Liège, Liège, Belgium*

*2EPNM, Department of Physics, Université de Liège, Liège, Belgium*

*3Liège Space Center (CSL), Liège, Belgium*

*4LMGP, INP Phelma, Université Grenoble-Alpes, Grenoble, France*

*\* abaret@uliege.be*

Silver nanowire (AgNW) networks are emerging as a leading class of Transparent Conducting Materials (TCMs), offering a unique combination of high optical transparency, excellent electrical conductivity, mechanical flexibility, and scalable, cost-effective production routes. This association of properties makes them key building blocks for a wide range of devices such as photovoltaic cells, OLEDs, transparent heaters, sensors or smart windows[1]. The conductivity of AgNW networks arises from a percolation mechanism through nanowire junctions, while their transparency results from gaps between the nanowires, illustrating an intrinsic interplay between these properties. Understanding the optical properties of AgNW networks, often described by their refractive indices (*n*, *k*), is critical for advancing their integration into multilayer systems and devices. Furthermore, refractive indices provide fundamental insight into the material’s optical behavior and enable accurate simulations of complex multilayer designs using the Transfer Matrix Method[2].

This study combines Mie’s scattering theory and van de Hulst’s mixing model to theoretically determine the refractive indices of AgNW networks without relying on fitting parameters. For the first time, refractive indices across the visible and near-infrared spectrum are calculated and validated upon experimental results. Transmittance spectra, derived from numerical solutions of Fresnel’s equations, show strong agreement with measurements, particularly for nanowires with larger diameters and at shorter wavelengths, with a relative error below 10% at $λ=550$ nm. Crucially, the findings of the present research also highlight for the first time in optical measurements the predominantly metallic optical behavior of AgNW networks deposited on glass substrates.

By accurately modeling the optical properties of AgNW networks, this work facilitates their integration into multilayer optical systems, supporting the development of innovative devices such as displays, sensors, and energy-efficient smart windows. Additionally, this research paves the way for a more advanced theoretical understanding of the optical properties of silver nanowire networks at the fundamental level.

## References

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