

Enhancing the Stability of Silver Nanowire Networks with TiO_2 Thin Films



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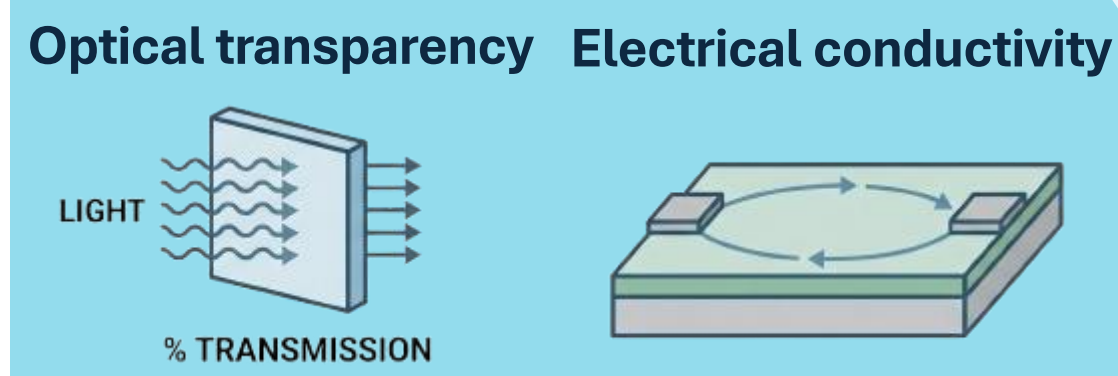
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Abstract

Transparent Conducting Materials (TCMs) are the essential backbone of modern optoelectronics, powering everything from touchscreens to smart windows. Silver Nanowire (AgNW) networks have emerged amongst the top TCMs, delivering excellent electro-optical performance with high mechanical flexibility. However, bare AgNW networks suffer from poor thermal stability, hindering their integration into more complex multilayer stacks [1]. Consequently, they require protective metal oxide coatings to prevent structural degradation at high temperatures.

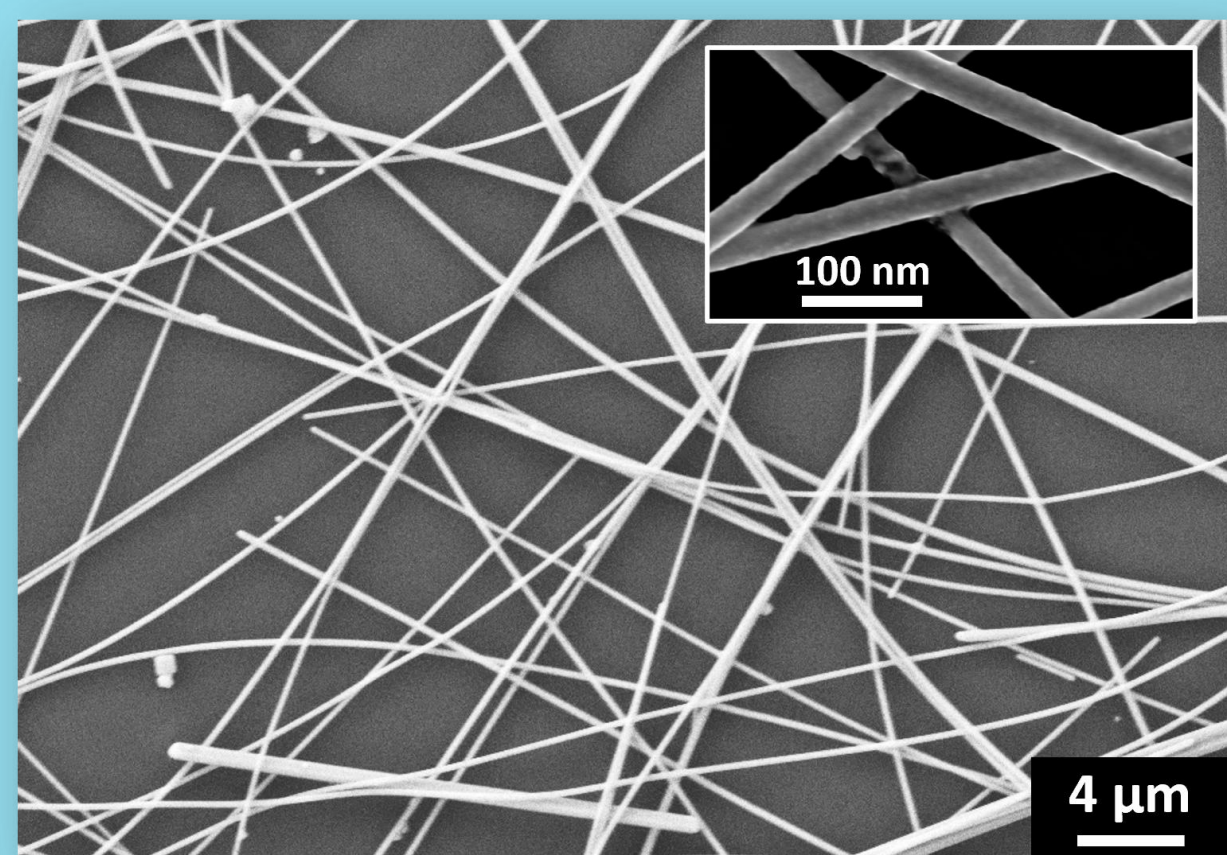
Key properties



Applications

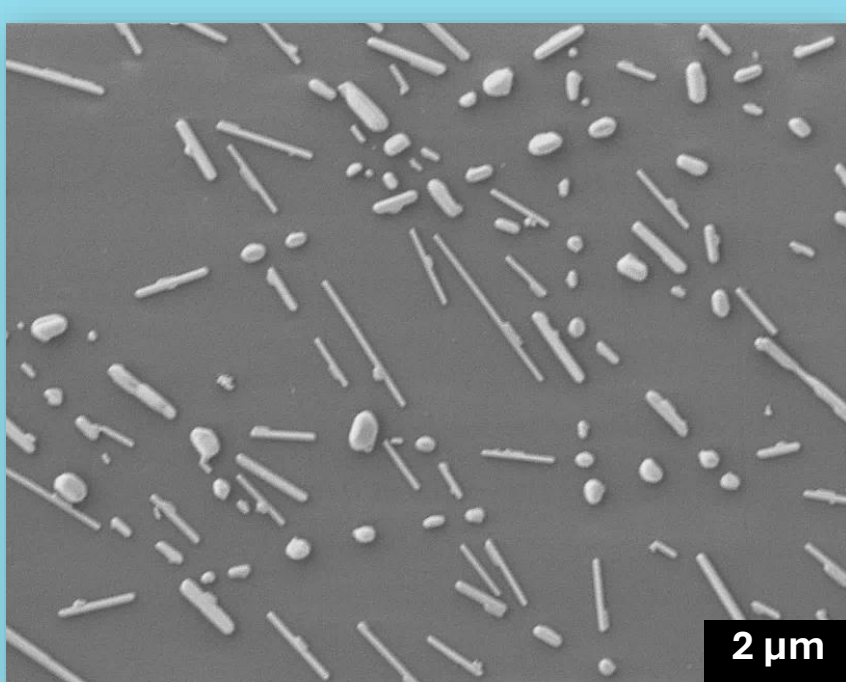
- Metallic nanowire networks
- Metallic oxides (ITO, etc.)
- Conducting polymers
- Graphene

AgNW networks



Scanning Electronic Microscope (SEM) image of an AgNW network

Spheroidization



$T > 250^\circ\text{C}$

Introduction

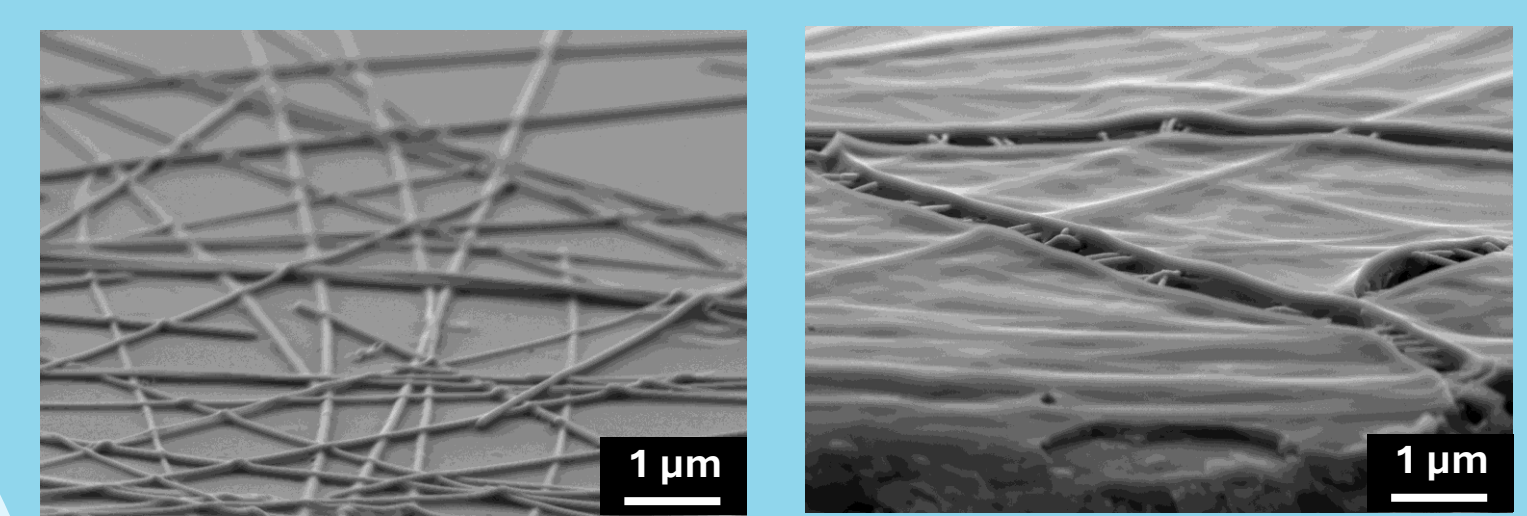
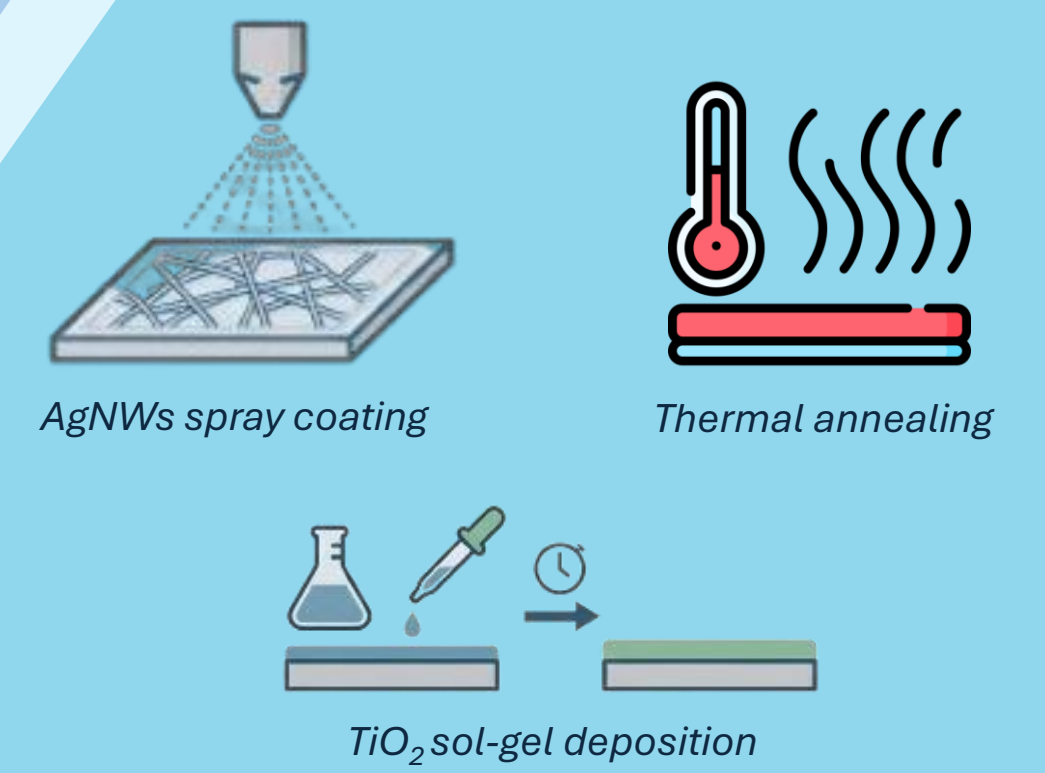
Key concepts

- ➔ Fabrication of **efficient** AgNWs-based TCMs
- ➔ Systematic **electro-optical** and **morphological** characterization
- ➔ Demonstration of the **relevance** of using **TiO_2** as a **protective coating** for AgNW networks

TCMs in general

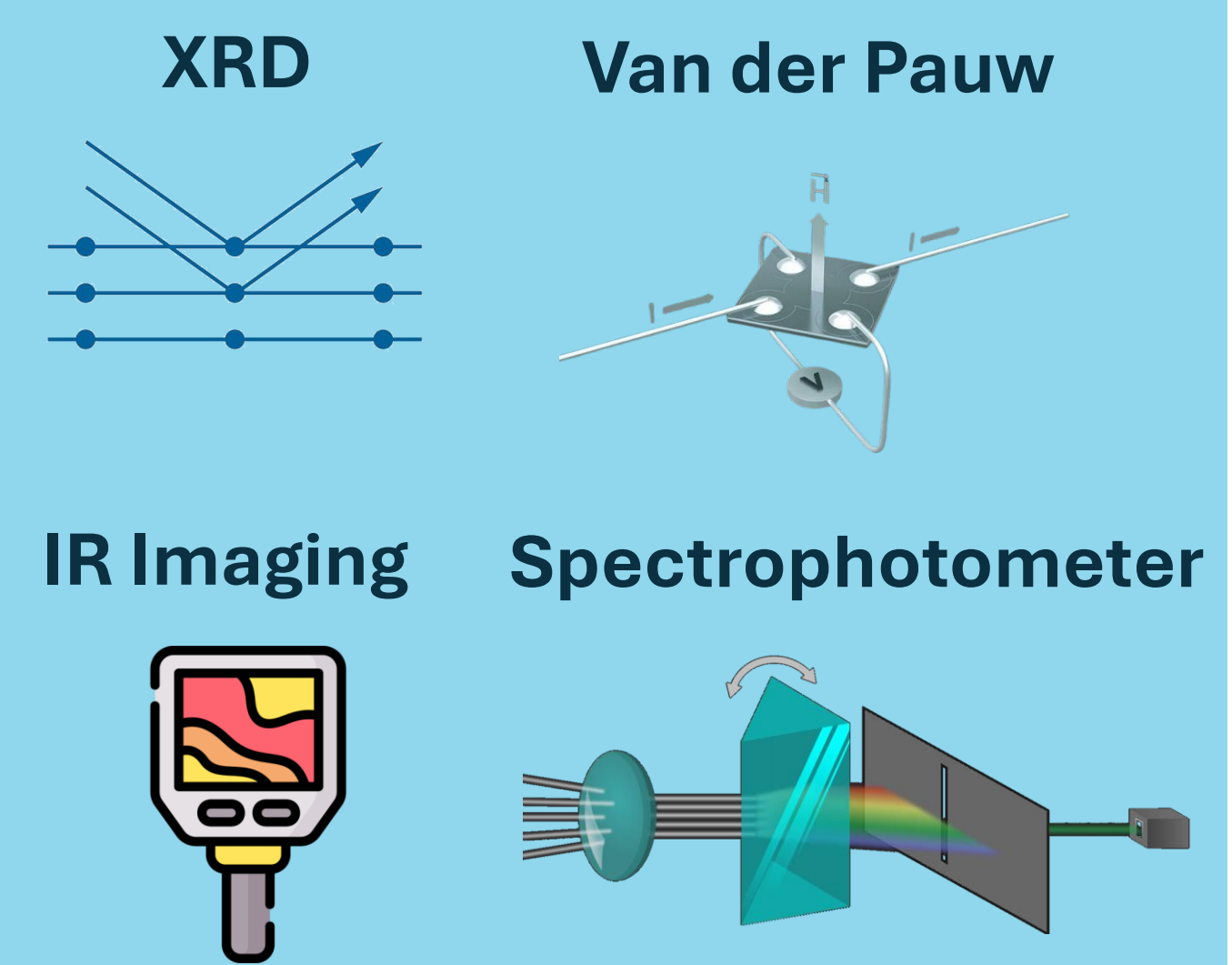
Experimental methods

Fabrication



Scanning Electronic Microscope images of TiO_2 -coated AgNW networks

Characterization



[2-4]

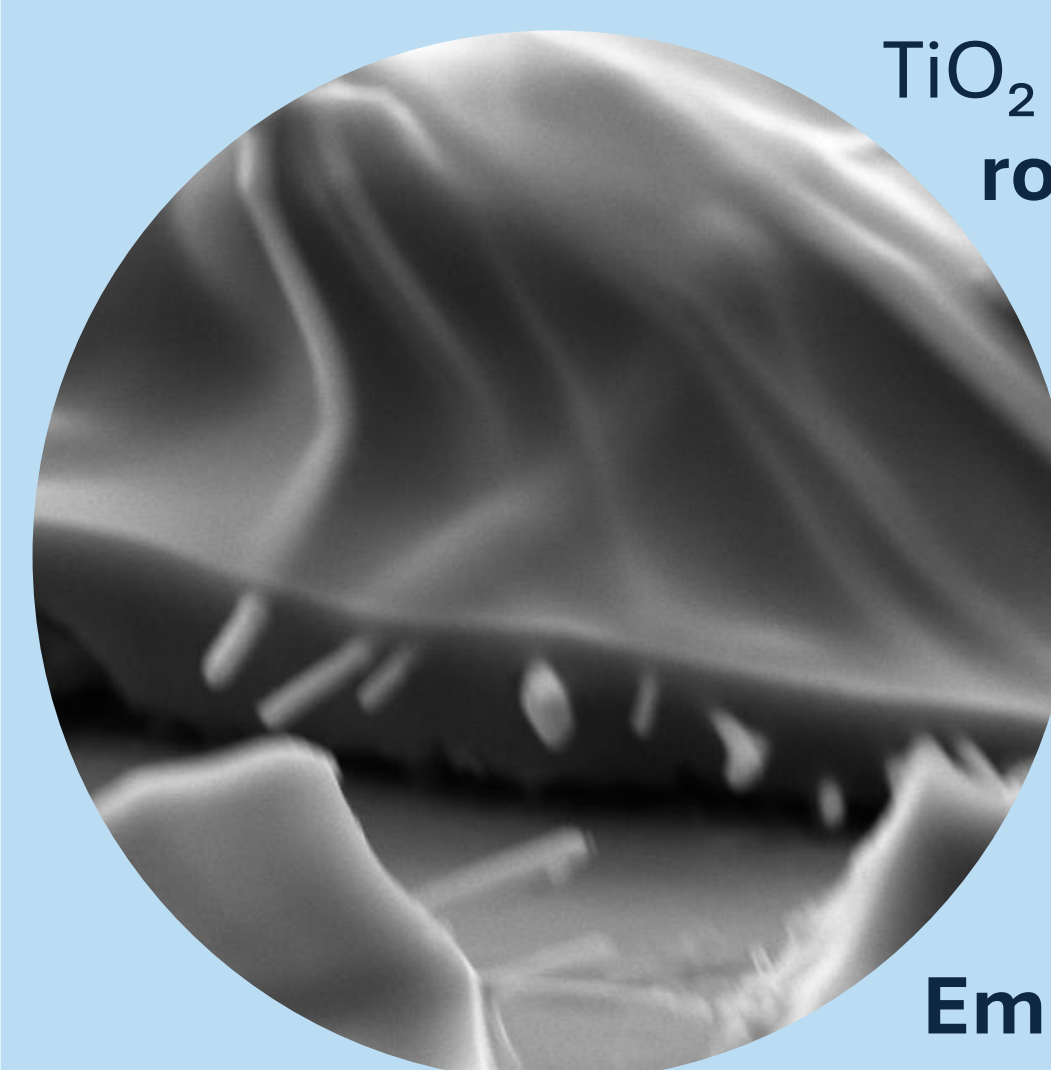
Results

Key findings

- ➔ Clear **linear** impact on **optical** properties
- ➔ Slight **increase** in **thermal emissivity**

Conclusions

In summary



TiO_2 sol-gel coatings **unlock more thermally robust** AgNW electrodes.

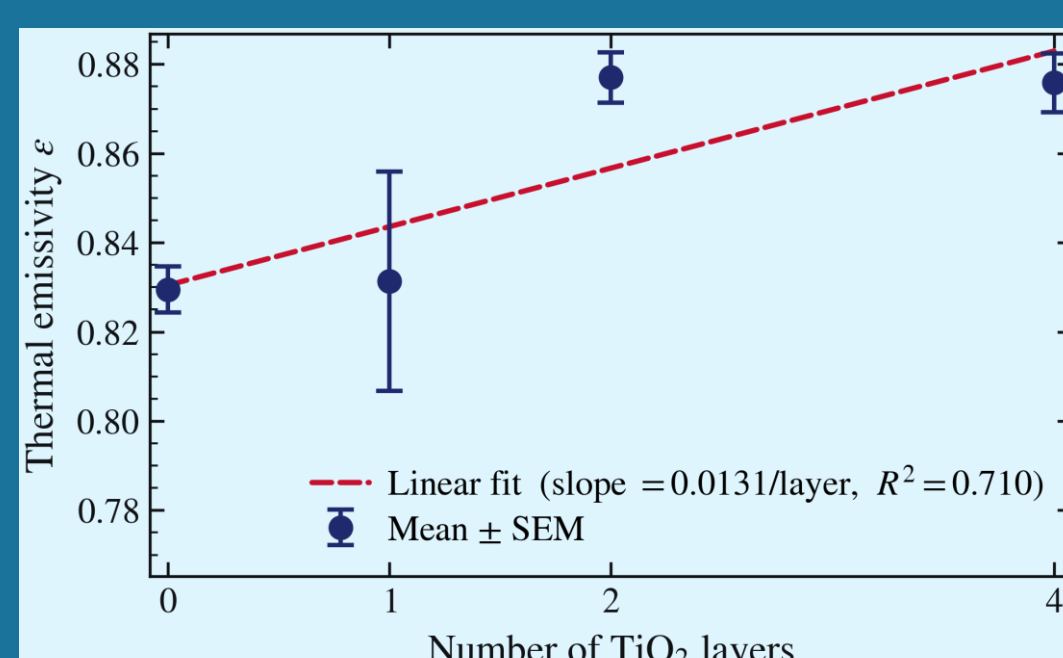
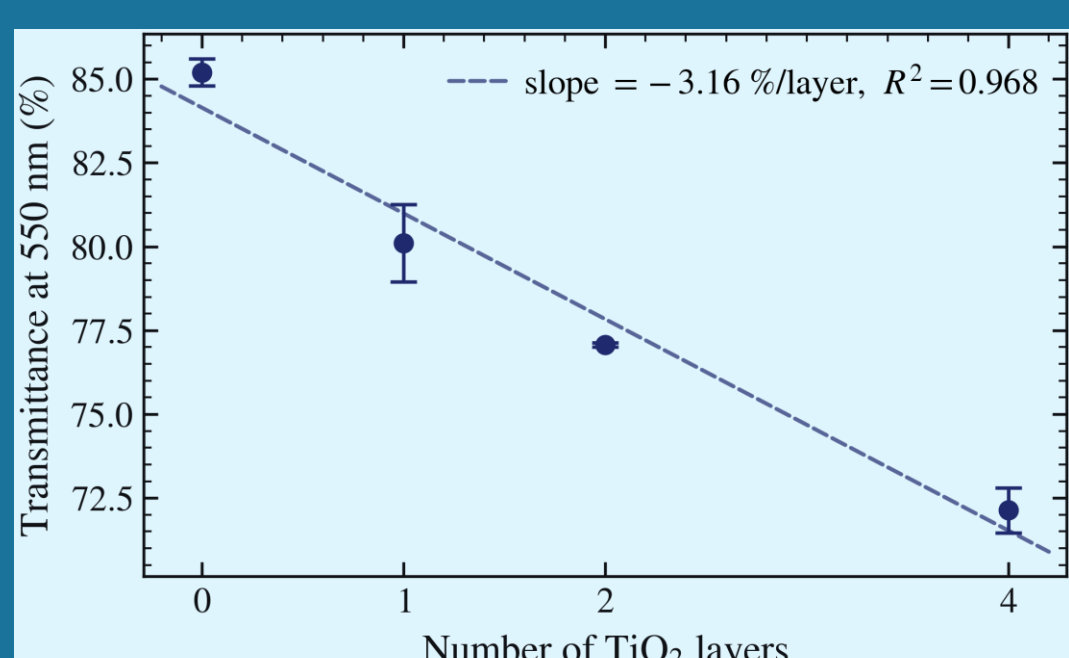
2 layers is optimal: **+55% lifetime** at 250°C , **>77% transmittance** retained.

Predictable electro-optical **cost**.

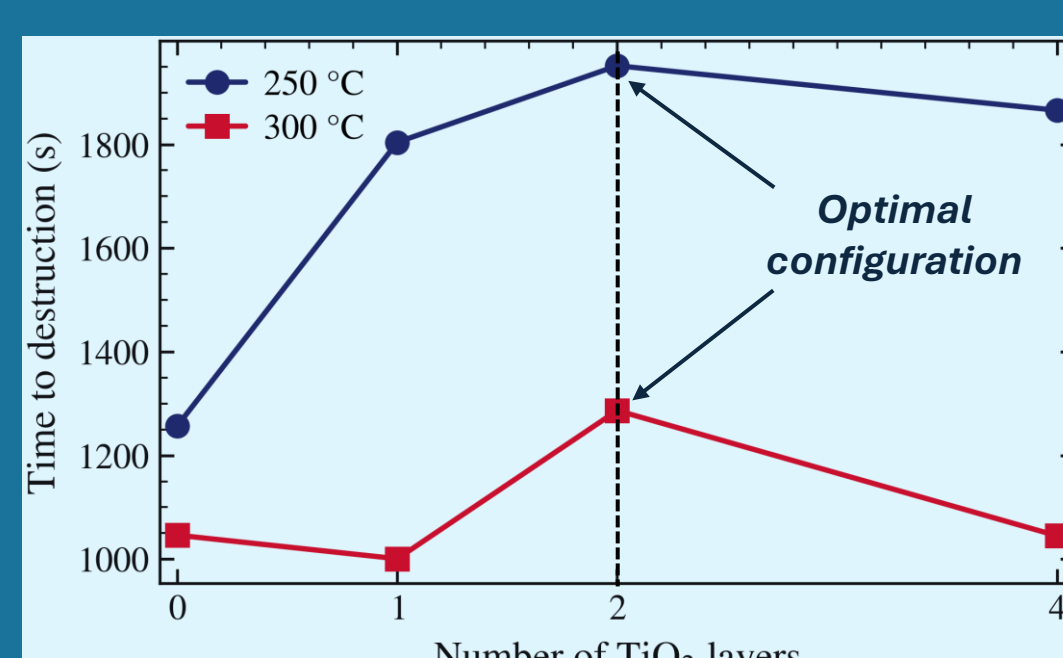
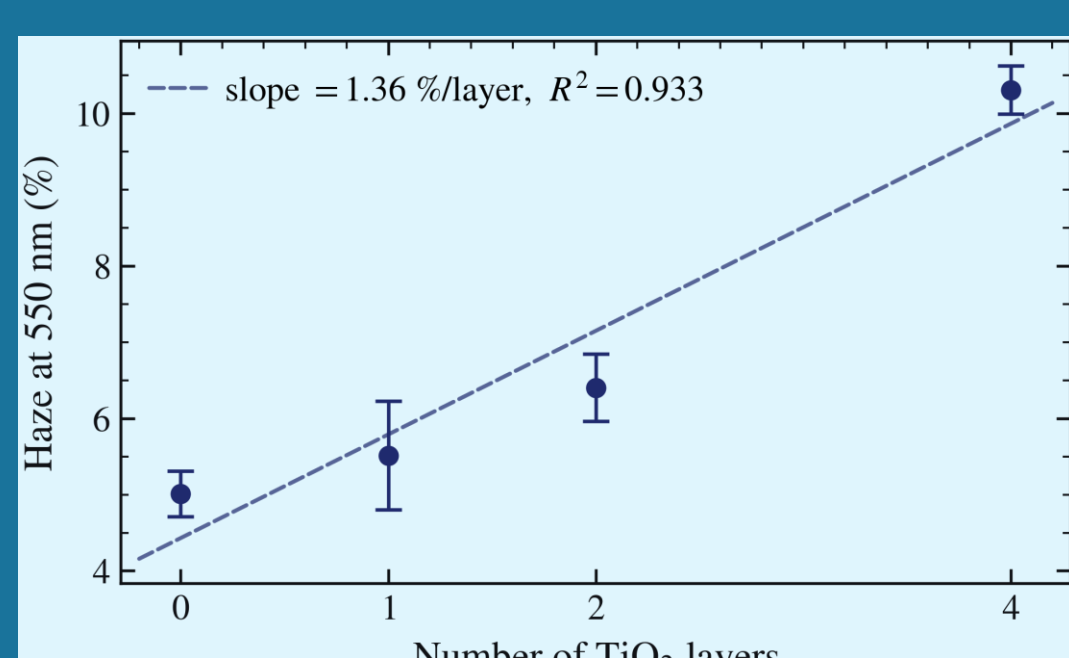
Emissivity rises with thickness ($0.83 \rightarrow 0.88$): a **trade-off**, or a **feature** for radiative thermal control.

Perspectives

- Improvement of the **chemical synthesis** of TiO_2
- Investigation of the **electrical** and **mechanical stability**
- **Real device integration**



Low- ϵ applications should consider the impact of the **coating** on the **emissivity** of the stack.



TiO_2 helps **delay** the degradation but **does not prevent** it. At 4 deposited layers, **mechanical stress** hinders the stabilizing effect. **Optimal: 2 layers**

References

- [1] Balty, F. et al., Journal of Colloid and Interface Science, 673, 574-582 (2024).
- [2] What is Raman Spectroscopy? Raman Spectroscopy Principles, Edinst (2021).
- [3] The difference between spectroscope, spectrometer and spectrophotometer, Silicann (2020).
- [4] Use Hall Effect Measurements for the Characterization of New and Existing Materials, Tektronix (2017).

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