



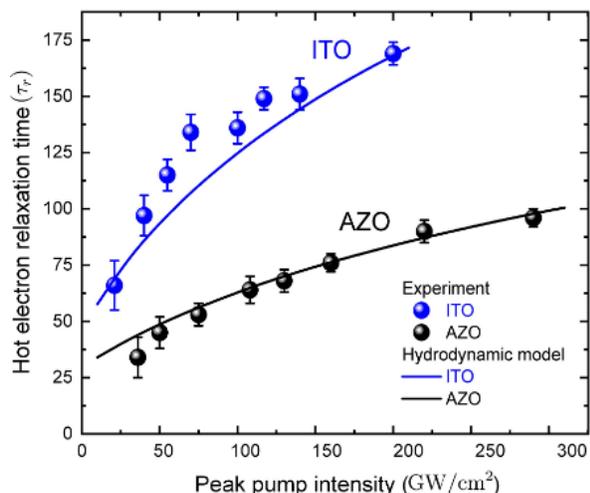
## ARRADIANCE Sneak Preview

### ALD Unlocks Next-Generation Optical and Quantum Computing

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Modern optical technology for quantum computing requires materials able to manipulate light on extremely fast timescales, allowing rapid control of “hot electrons” (electrons energized by light) inside a material. Transparent conductive oxides (TCO) represent attractive class of materials due to their extremely low electrical permittivity or so-called *epsilon-near-zero* (ENZ) properties, enabling confinement and manipulation of light within ultrathin films – a crucial behavior for ultrafast all-optical applications. Chemical robustness, low specific heat capacity and high optical damage threshold of ENZ TCOs will enable next generation quantum computing optical device components such as ultrafast switches, transistors, and logic gates.

Recent pioneering work published in [Science Advances](#)<sup>1</sup> compares properties of two TCOs: sputtered indium-tin oxide (ITO) and Arradiance’s GEMStar™ ALD-grown aluminum-zinc-oxide (AZO). The study focused on experimental characterization and theoretical modeling of ultrafast (femtosecond laser pulses) optical performance. For target film thicknesses (200-300nm),



wavelengths (1-1.5μm) and energy densities evaluated, AZO delivered twice the speed of ITO and was more than 20 times faster than gold, likely due to TCOs possessing lower conduction electron concentrations but higher electron mobility than metals.

This study discovered previously unrevealed insights into ultrafast electron dynamics in ENZ materials. The authors suggest the expandability of their models to a wider optical range from UV to mid-infrared by choosing other materials for different wavelengths, including metal oxides, polymers, 2D-materials like graphene, and artificially structured plasmonic nanostructures. ALD provides an engineering platform enabling precise control of the composition and thickness of the film, yielding predictable and repeatable performance. This precision represents the key to scaling optical and quantum devices from the lab into reliable technologies.

Arradiance enables thin-film semiconductors, optical, sensing, and advanced energy state-of-the-art ALD solutions. For more information on Arradiance Technology, ALD Systems or Foundry Services, please [contact Arradiance](#).

<sup>1</sup>. Sudip Gurung et.al., ” Control of ultrafast hot electron dynamics in epsilon-near-zero conductive oxide thin films”. *Science Advances*, Vol 11, Issue 21 (May 2025) DOI: [10.1126/sciadv.adu8850](https://doi.org/10.1126/sciadv.adu8850)