**Insight into the morphological instability of**

**metallic nanowires under thermal stress**

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Silver nanowires (AgNWs) are key components in emerging transparent conductive materials, offering a scalable, flexible, and high-performance alternative to brittle oxide-based conductors. Yet, their long-term stability remains a critical concern. It is well known that, under thermal stress, AgNWs spontaneously fragment into periodic chains of nanospheres, even at temperature more than 600°C below the bulk melting point of silver. This degradation mechanism drastically reduces network conductivity.

This instability has often been described by analogy with the Plateau–Rayleigh instability of liquid jets [1]. However, this fluid-based framework fails to quantitatively match experimental observations in solid-state nanowires [2]. In this work, we revisit the origin of this phenomenon using a solid-state diffusion model initially proposed by McCallum et al. [3], which considers curvature-driven mass transport in a solid “line of thin film” resting on a substrate, an approach that motivated this work.

High-resolution electron microscopy is used to monitor the thermal evolution of nanowires with varying diameters, and statistical analysis of the resulting breakup wavelengths is compared to both Rayleigh’s predictions and the solid-state model of McCallum et al.

These findings refine our understanding of how nanowire morphology evolves under heat and provide a theoretical basis for temperature-induced failure in AgNW networks [4]. By identifying the relevant physical mechanism underlying thermal degradation, this work contributes to the design of more stable and reliable transparent conductors for optoelectronic devices operating under demanding conditions.

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[3] M.S. McCallum, P.W. Voorhees, M.J. Miksis, S.H. Davis, H. Wong, *Capillary instabilities in solid thin films: lines*, J. Appl. Phys. **79** (10) (1996) 7604–7611.

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