

Supplementary information

"First observation of dual electrical-optical percolation in metallic nanowire networks"

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Figure S1- Scanning Electron Microscopy (SEM) images of AgNWs before and after thermal annealing.

Thermal annealing was conducted at 200 °C, in air, for 1 hour prior to any characterizations to optimize electrical resistance of networks.

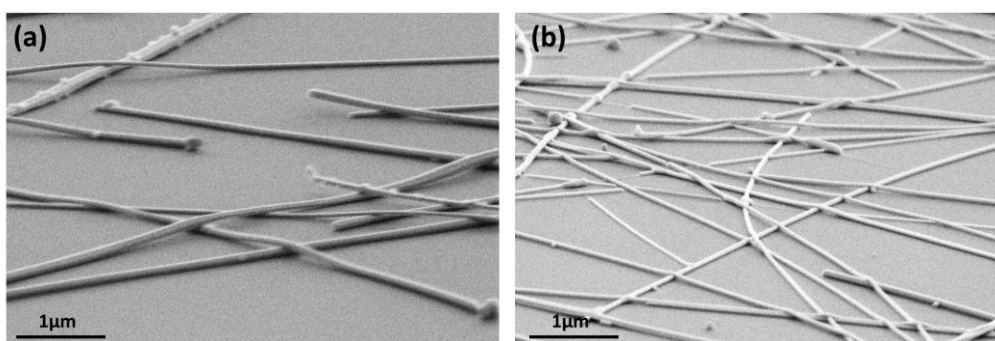


Fig. S1. SEM images of AgNWs (a) before and (b) after thermal annealing.

The SEM images (see Fig. S1) illustrate the AgNW junctions (a) before and (b) after this treatment, highlighting the improved contact between nanowires. But the individual nanowires remain the same diameter and length.

Figure S2- Comparison of sheet resistance before and after thermal annealing for AgNW networks.

All networks show a reduction in sheet resistance after annealing¹, with the most pronounced decrease—up to several orders of magnitude—observed in sparse networks. In contrast, high-density networks exhibit a relatively smaller drop, as their initial contact connectivity is already superior prior to treatment. This annealing step ensures all samples reach an optimized electrical baseline for subsequent characterizations. Fig. S2 exhibits a comparison of sheet resistance measured before and after thermal annealing for AgNW networks with 4 different dimensions: (a) Ag58, (b) Ag73, (c) Ag95, (d) Ag112.

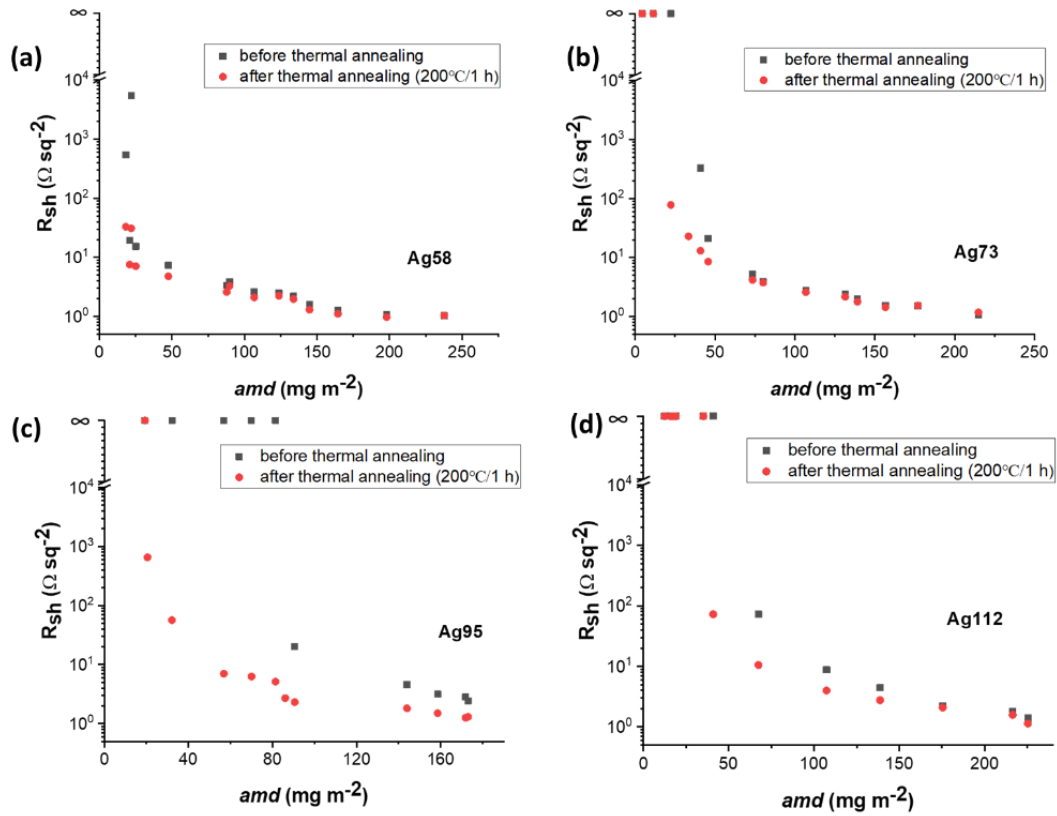


Fig. S2. Comparison of sheet resistance before and after thermal annealing for AgNW networks with 4 different dimensions: (a) Ag58, (b) Ag73, (c) Ag95, (d) Ag112.

Figure S3- Comparison of visible transmittance and infrared emissivity before and after thermal annealing for the Ag58

This supplementary data is used to confirm that thermal annealing has no significant influence on the visible transmittance and infrared emissivity.

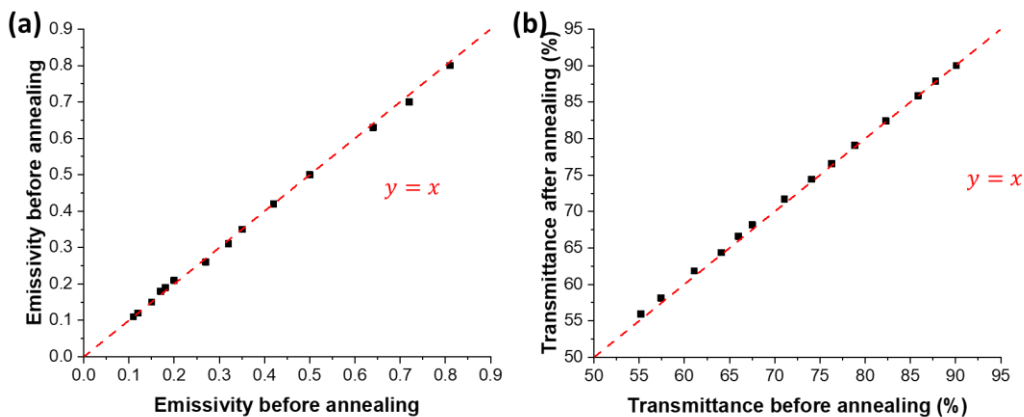
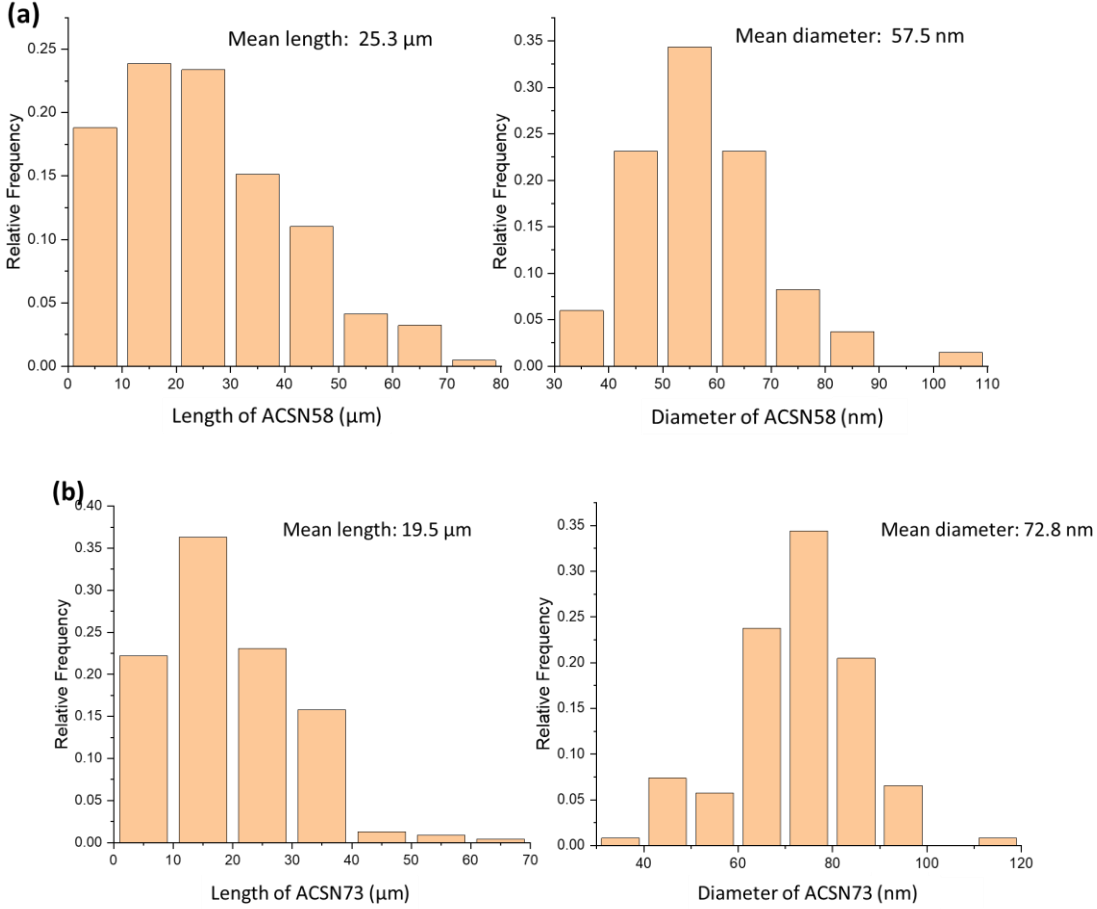


Fig. S3. Comparison of infrared emissivity (a) and visible transmittance (b) before and after thermal annealing for the Ag58.

Both properties remain nearly identical after the treatment, demonstrating that the thermal annealing process (200 °C, 1 h in air) does not alter the fundamental optical or emissive characteristics of the AgNW networks.

Figure S4- AgNW diameter and length distribution for 4 AgNW types used in this study.

The histograms provide the average geometric parameters used to accurately calculate the areal mass density (*amd*) for each network.



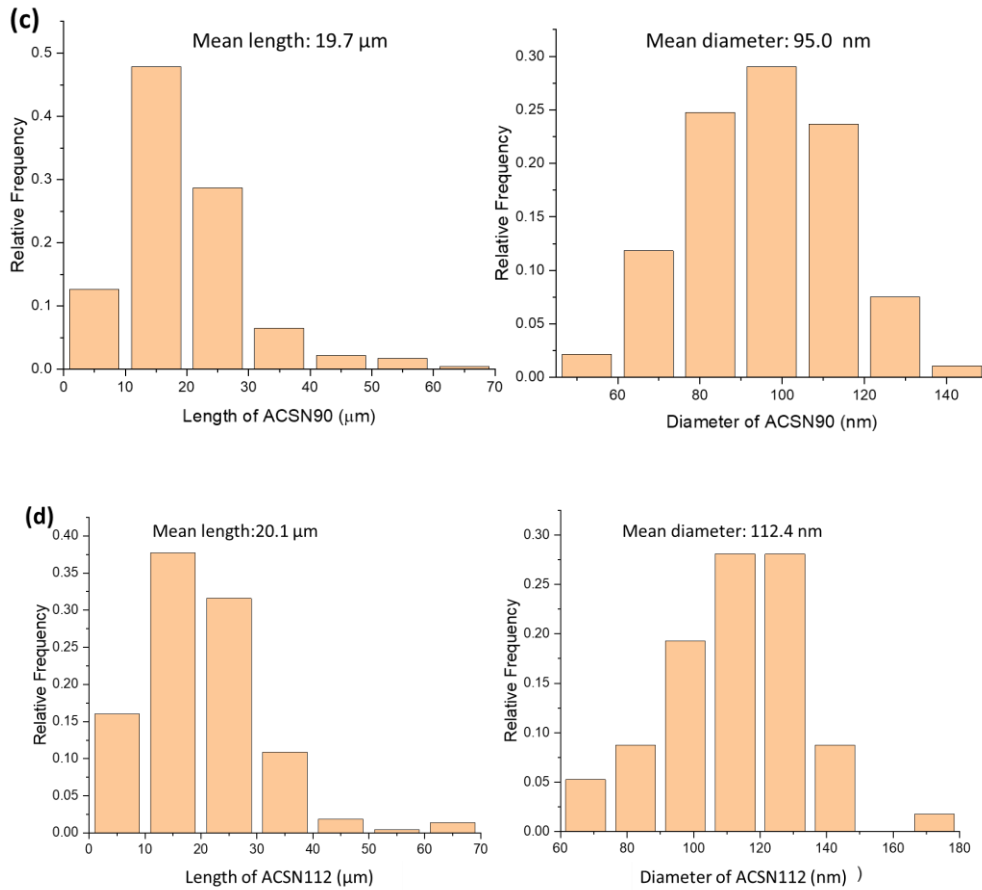


Fig. S4. Diameter and length distribution for 4 AgNW types used in this study. (a) Ag58, (b) Ag73, (c) Ag95, (d) Ag112.

Figure S5- Sensitivity analysis of the optical threshold with respect to different observation angles pairs.

This analysis demonstrates the consistency of the identified critical optical amd, showing that the transition from dielectric-like to metallic-like behaviour is independent of the specific pair of angles chosen for comparison. The robust trend confirms that the observed threshold is a reliable physical characteristic of the network.

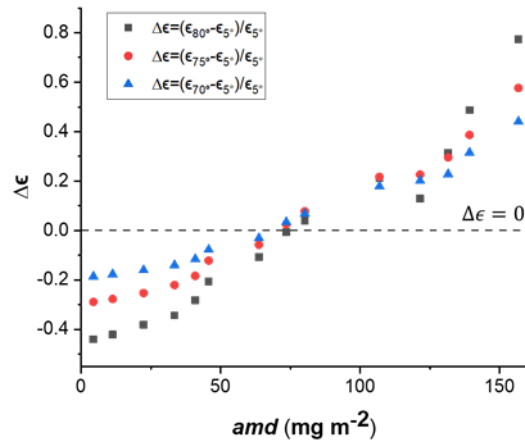


Fig. S5. Sensitivity analysis of the optical threshold with respect to different observation angles pairs.

Figure S6- Comparison of angular emissivity on different substrates.

Single-crystal Si wafers were used as substrates for comparison with glass substrate used in this work, as they have much higher infrared transmittance compared to glass. To ensure a pristine surface, the wafers were immersed in a 1% HF solution for 30 seconds to remove the native SiO₂ layer.

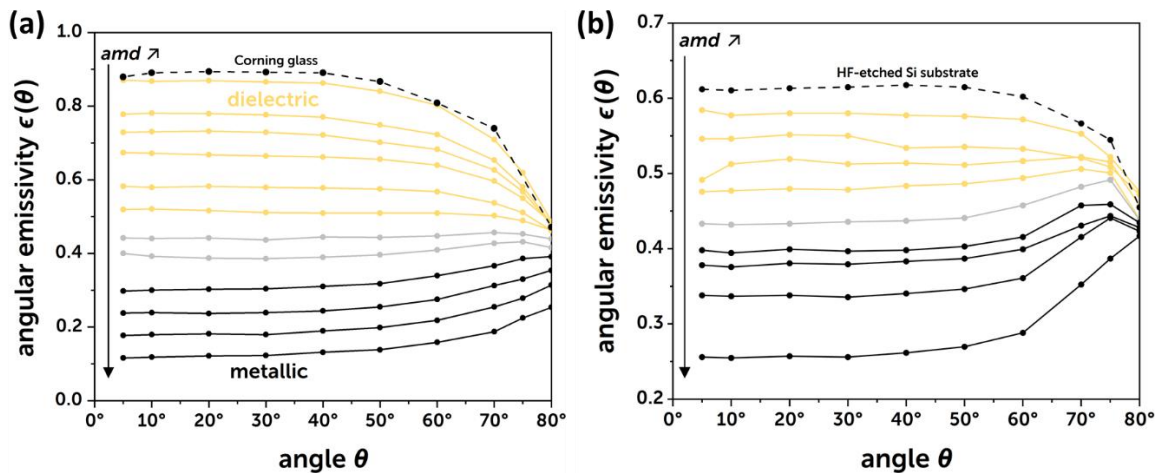


Fig. S6. Comparison of angular emissivity on different substrates. (a) Corning glass, (b) Infrared-transparent silicon wafer.

Ag73 was selected as a representative AgNW type to evaluate the influence of the substrate background. The consistent angular response across different substrates confirms that the emissive behavior is primarily governed by the AgNW network properties rather than the substrate characteristics.