Correlative Characterization of Nanowires Using FusionScope®

Characterizing individual nanowires across surface, electrical, and mechanical domains is inherently difficult. Conventional workflows rely on multiple instruments, introducing alignment errors, loss of nanoscale regions of interest (ROI), and poor correlation between datasets. These limitations slow development and reduce confidence in results.

FusionScope eliminates these challenges by enabling fully correlative nanoscale characterization within a single platform. By integrating AFM, SEM, EDS, and micromanipulation into a unified system, it ensures precise, repeatable measurements on the exact same nanowire—without sample transfer and without loss of ROI integrity.

Unlike conventional multi-instrument approaches, FusionScope maintains spatial correlation across all measurements, enabling direct, reliable comparison of structural, electrical, and compositional data on a single feature.

Why FusionScope?

FusionScope combines complementary nanoscale techniques within a shared coordinate framework, enabling seamless transitions between imaging, probing, and analysis.

This delivers:

- Consistent relocation of the same nanowire across all measurement modes
- Direct correlation of multimodal data on a single structure
- Elimination of instrument switching, reducing measurement time and complexity
- Higher confidence in results through integrated validation
- Precise AFM positioning using Profile View for true nanoscale targeting

By removing the need for sample transfer and re-alignment, FusionScope eliminates a fundamental bottleneck in nanowire characterization: the inability to reliably measure multiple properties on the same structure.

Application Examples

Surface Characterization of Silicon Nanowires (Si-NWs)

Accurate control of nanowire geometry and surface roughness directly impacts device performance. Vertically aligned silicon nanowires fabricated via deep reactive ion etching were analyzed (Figure 1) **[1]**.

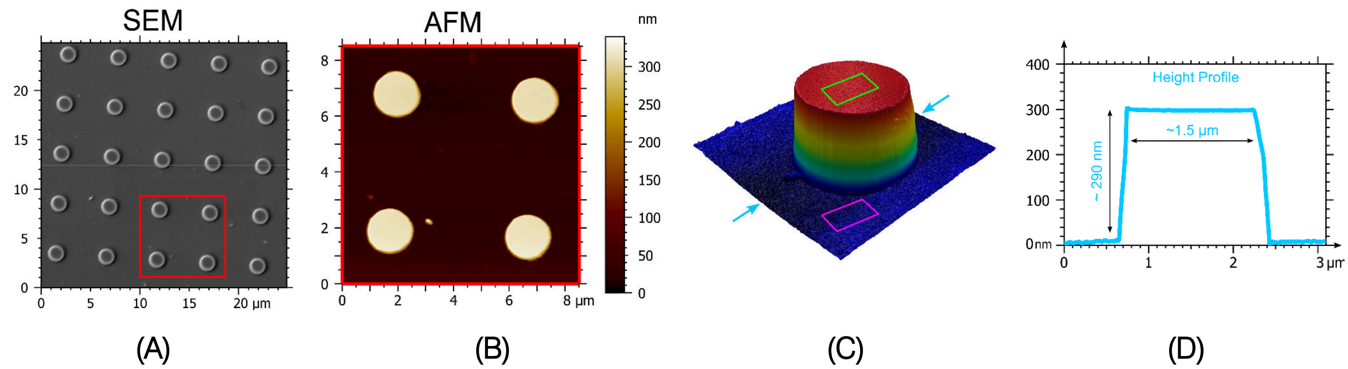


*Figure 1: **(A)** SEM top view of a Si-NW Array. The red rectangle marks an arbitrary region in which the AFM image shown in **(B)** was subsequently acquired. In **(C)**, a three-dimensional topographic representation of a single nanowire is presented, with blue arrows indicating the start and end points of the height profile extracted and shown in **(D)**.*

FusionScope enabled rapid identification of individual nanowires via SEM, followed by precise AFM positioning using the shared coordinate system.

Measured results:

- Top surface roughness: ~0.3 nm
- Bottom roughness: ~2 nm
- Sidewall roughness: ~13 nm

These measurements provide direct, quantitative insight into nanoscale surface features on individual nanowires — critical for optimizing fabrication processes and ensuring reproducible device behavior.

Electrical Characterization of Zinc Oxide Nanowires (ZnO-NWs)

Electrical characterization at the single nanowire level requires precise probe placement and validation of contact integrity.

Using FusionScope, a micromanipulator probe was positioned onto an individual ZnO nanowire on an N-type silicon substrate with a Cr/Au electrode (Figure 2) **[2]**.

The system provided:

- High-precision probe placement guided by SEM
- Acquisition of I-V characteristics showing ohmic behavior
- Resistance measurements in the range of 1-50 kΩ

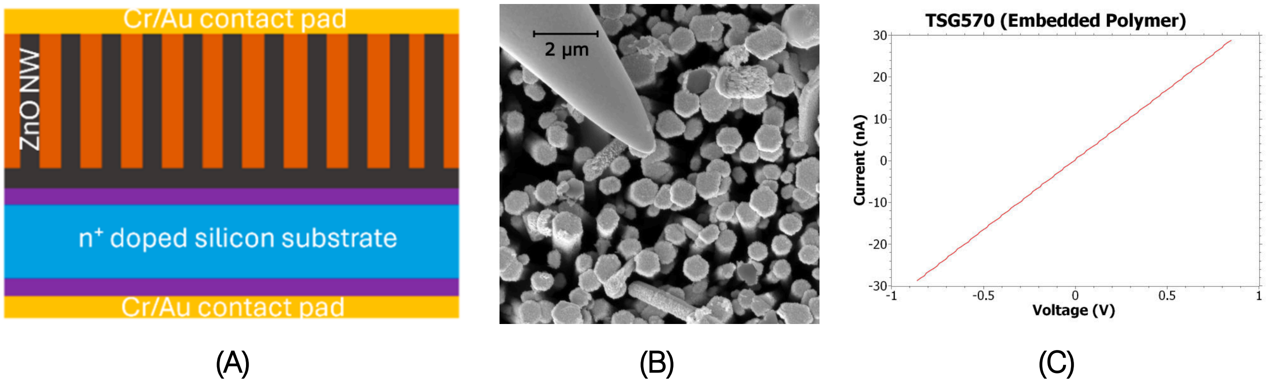


Figure 2: ***(A)*** *Schematic of the ZnO nanowire sample.* ***(B)*** *Micromanipulator needle inside the FusionScope positioned on top of a single ZnO nanowire.* ***(C)*** *I/V-curve measured on the single ZnO nanowire.*

Simultaneously, EDS and AFM verified electrode deposition quality and surface morphology (Figure 3).

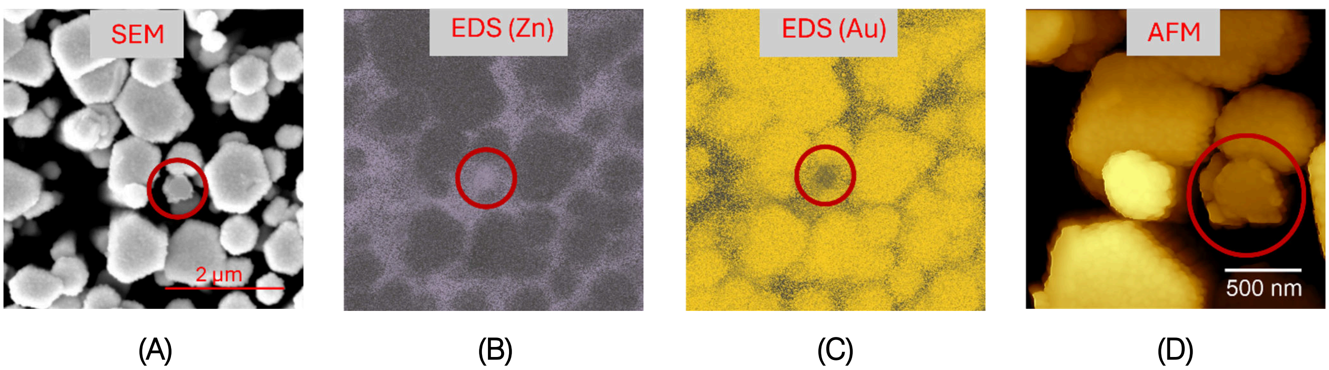


Figure 3: SEM/AFM and EDS measurements on the same ZnO NWs. The red circle indicates a nanowire exhibiting imperfect Cr/Au deposition.

This integrated workflow ensures that electrical measurements reflect intrinsic nanowire properties, eliminating ambiguity caused by contact defects or material inconsistencies.

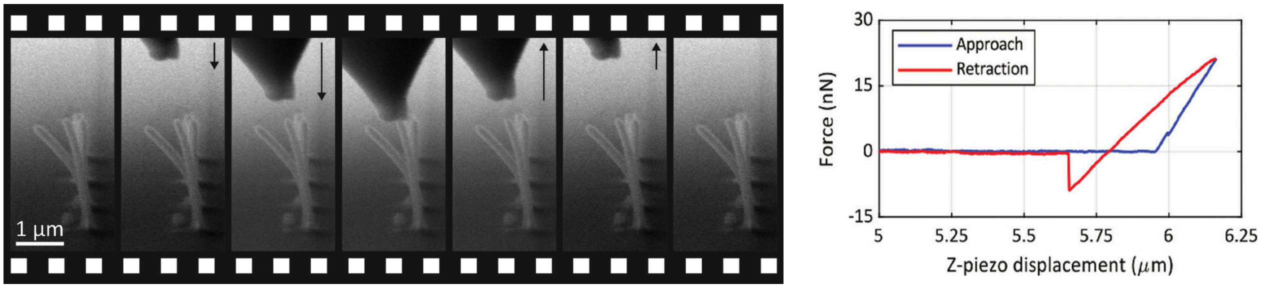
Mechanical Characterization of 3D Nanoprinted Platinum Nanowires

Mechanical performance is a key requirement for nanowires used in flexible and wearable technologies.

FusionScope enables targeted mechanical testing by positioning the AFM tip directly on individual nanowires using SEM guidance and Profile View (Figure 4) **[3]**.

Force–distance measurements yielded a spring constant of approximately 0.1 N/m.

This approach provides direct, nanoscale measurement of mechanical properties, enabling accurate assessment of material behavior, structural integrity, and device reliability.



(A) (B)

Figure 4: ***(A)*** *Representative frames extracted from a time-resolved SEM video capturing the approach and retraction sequence of the AFM cantilever* ***(B)*** *the corresponding Force-Distance Curve is shown.*

Conclusion

FusionScope delivers a uniquely integrated solution for nanowire characterization by enabling correlative SEM, AFM, EDS, and micromanipulation within a single platform.

By ensuring that all measurements are performed on the same nanowire without repositioning, it eliminates a major source of error in nanoscale analysis. The result is faster workflows, higher-confidence data, and true multimodal insight into nanowire behavior.

For researchers and engineers working at the nanoscale, FusionScope provides a reliable and efficient path to comprehensive characterizations supporting faster development and more informed decisions.

References

[1] J. Xu, et al., "Deep-Reactive Ion Etching of Silicon Nanowire Arrays at Cryogenic Temperatures," *Applied Physics Reviews*, **2024**, 11, no. 2, p. 021411, doi: 10.1063/5.0166284.

[2] F. E. B. Anang, et al., "Nondestructive Mechanical and Electrical Characterization of Piezoelectric Zinc Oxide Nanowires for Energy Harvesting," *Micromachines*, **2025**, 16, no. 8, doi: 10.3390/mi16080927.

[3] A. Alipour, et al., "A Highly Integrated AFM-SEM Correlative Analysis Platform," *Microscopy Today*, **2023**, 31, no. 6, pp. 17-22, doi: 10.1093/mictod/qaad083.