Docket #: S12-011

A general and effective sol-flame method to dope nanowires and thin films

Stanford researchers have discovered a novel method of doping nanowires (NW) and thin films (TF) that greatly improves surface area and performance. The sol-flame method is a fast, simple and low cost way to introduce dopants into NW and TF for a wide variety of applications. The high temperature and ultra-fast heating rate of the flame enables rapid diffusion of dopants while shortening the annealing treatment duration to seconds. In addition, the brief flame exposure avoids damage to more delicate substrates such as glass. This method is general enough to work with many NW and nanoparticle (NP) materials and offers unprecedented engineering control as well.

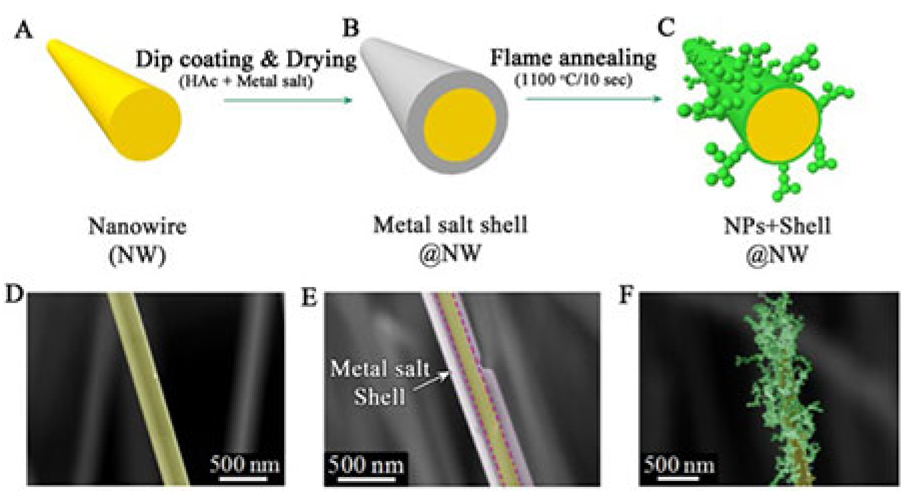

Figure Caption: Schematic illustration of the general sol-flame synthesis process for hybrid NP@NW nanostructures. The NWs (A) are dip-coated with the precursor solution of NPs and then dried in air (or N2) to form a metal salt shell on the NWs. Then coated NWs (B) are annealed in the flame, forming a NP-chain morphology (C). The corresponding SEM images of (D) CuO NW, (E) Co(CH3COO)2 shell@CuO NW, and (F) Co3O4NP@CuO NW.

Stage of Research:
Reduced a 1cm by 1cm sample of doped TiO2 nanowires with W to practice.

Applications

- This method can be used to dope various semiconducting nanowires and thin films to
- modify their electrical and optical properties, so that these materials can be used in
- diverse application fields, such as:
- Transparent conducting oxides (TCO)
- Photoelectrochemical (PEC) water splitting devices
- Photocatalysis
- Heterogeneous catalysis
- Polymer-based solar cells
- Semiconductors
- Toxin and explosive detection

Advantages

- Dramatically increases nanowires and thin film performance
- Permits greater engineering control
- nanoparticle's density (from tens to hundreds of particlres per square micrometers)
- nanoparticle's size (from tens to hundreds of nanometers)
- Localized doping
- Multi-elements doping
- Many fold increase in surface area (see figure)
- Works with many nanowire and nanoparticle materials
- Ex-situ doping **without** changing the starting morphology and crystal structure of the nanowires
- No limitation on substrates - both oxides and non-oxides substrates
- Low cost- **no** vacuum required
- Easy to use and simple set-up

Publications

- Feng, Y., et al., Sol-Flame Synthesis of Hybrid Metal Oxide Nanowires, submitted for oral presentation at the 34th International Symposium on Combustion and for publication in the Proceedings of the Combustion Institute (July 29-August 3 2012, Warsaw University of Technology, Poland).
- Y.Feng, I.S.Cho, P M. Rao, L. Cai, and X. Zheng, Sol-Flame Synthesis: A General Strategy To Decorate Nanowires with Metal Oxide/Noble Metal Nanoparticles , NanoLetters, Published online 17 April 2012.
- Bejeweled: Stanford nanotech gets boost from nanowire decorations, Stanford Report, published online April 30, 2012.

Patents

- Published Application: 20140294721

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