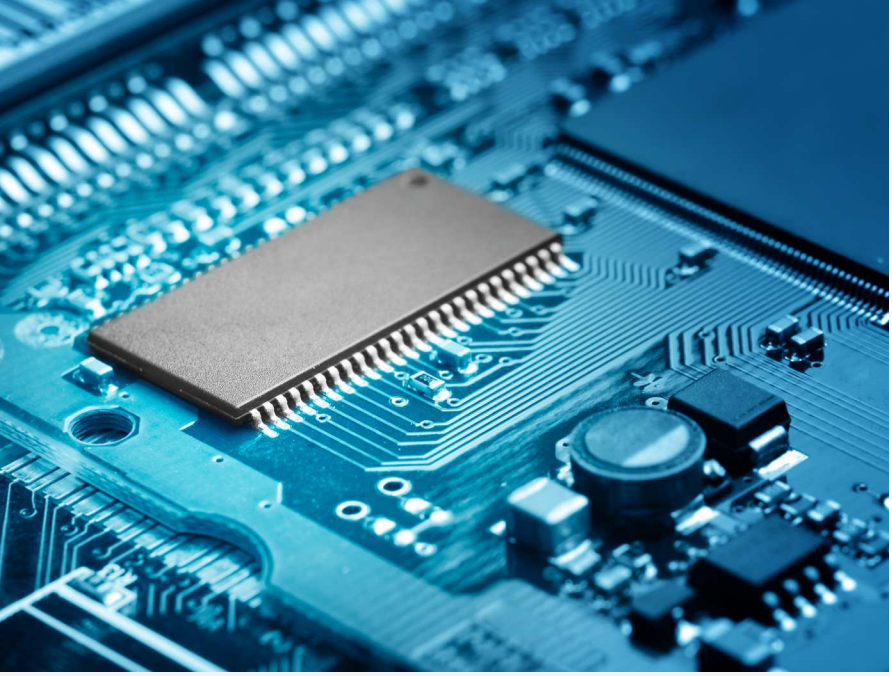


National Aeronautics and
Space Administration

Manufacturing

Copper Nanowire Production for Interconnect Applications

A simple and inexpensive approach to produce copper nanowires directly

Copper replaced aluminum early two decades ago as an interconnect material in integrated circuit manufacturing due to its better electrical and thermal conductivity. Metallic nanowires have interesting physical properties such as quantized conductance and localization effects. These properties can be exploited for applications such as wiring in nanometer scale circuits, and probes for atomic force microscope and scanning tunneling microscope. NASA has developed a new technology that can produce copper nanowires directly. This technology provides a simple method to produce copper nanowires on a substrate as an alternative to template approaches and chemical synthesis routes. Copper oxide nanowires (CuOandCu2O) are produced from copper film, foil, or commercially available copper wires of any size, through oxidation using a vapor phase technique known previously. The copper oxide nanowires are then reduced in a hydrogen atmosphere to produce the copper nanowires.

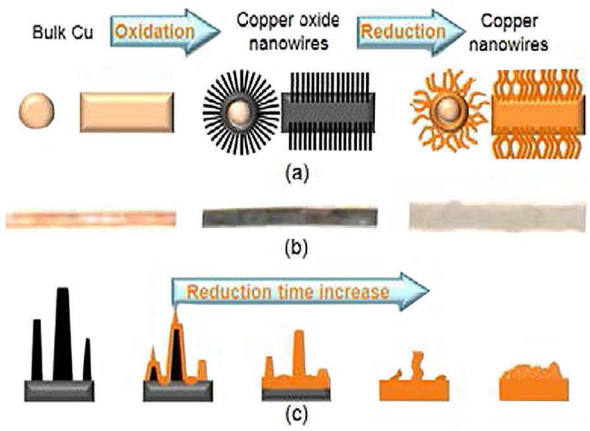
BENEFITS

- Better electrical conductivity
- Simple and inexpensive synthesis approach
- Nanowire growth is based on self-catalytic mechanism
- Very low reflectivity
- High absorption of visible light
- The oxide nanowires can be a mixture of CuO and Cu2O.
- Can be grown either vertically or laterally

technology solution

THE TECHNOLOGY

This technology presents a simple and inexpensive synthesis approach for direct growth of semiconducting copper oxide (CuOandCu2O) nanowires and their subsequent reduction to metallic copper (Cu) nanowires. Copper oxide nanowires are grown from conventional bulk copper wires by thermal oxidation. Both, CuOandCu2O. nanowires are produced first on Cu substrate in a simple quartz tube furnace system, using the most basic and primary methods of oxidation and reduction mechanisms. Oxidation is performed in ambient air, and then oxide nanowires are reduced to copper nanowires in the same furnace under a hydrogen flow at 400C. The reduction process effectively transforms the oxide nanowires in to metallic copper nanowires. The development mechanisms of these nanowires were studied by examining the sequential images of nanowires at different time intervals. Electrical characterization reveals a reduction of resistance by six orders of magnitude at the completion of the reduction process which implies that the reduced nanowires are reasonably metallic.



Schematic of the evolutionary transformation of nanowire

APPLICATIONS

The technology has several potential applications:

- Semiconductor industry
- Photodetectors
- Field emission devices
- Anodes for Li-ion batteries
- Nanometer scale circuits
- Probes for microscopes
- Solar cells
- Gas sensors
- Microheater

PUBLICATIONS

Patent No: 8,834,597

More Information

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