Technology Offer

Fabrication of ultrathin nano-porous membranes and semiconductor nanowires

Ref.-No.: 0104-4458-GÖ

Semiconductor nanowires are of vital importance for many applications, such as flexible electronics, photonics, sensors, and energy harvesting and storage devices. As standard fabrication procedure, vapor-liquid-solid (VLS) growth employs metal catalyst particles (such as gold) as seeds for growth of nanowires. The seeds are deposited on a solid substrate, melted by heating and then exposed to a gas atmosphere containing source materials of the semiconductor. When the metal droplets are supersaturated, nanowires grow out of the seeds.

However, this process can be operated only at high temperatures of 600 – 900 °C and is highly sensitive to the slightest variation of gas flow pressure, substrate temperature, and size of the catalyst seed particles. In consequence, semiconductor nanowires cannot be produced on an industrial scale to date.

Keywords

cheap and large-scale nanowires, ultrathin porous membranes, low temperature, reinforced metallized polymer setup of sensory motor couplings via a dedicated scripting keyword ('targeting')

Technology

Scientists at the Max Planck Institute for Intelligent Systems have developed a method for large-scale and cost-effective production of semiconductor nanowires and nanowire networks. As illustrated in Fig. 1, the method employs a thin film of metal (typically Al) with a columnar grain structure. Upon exposure of the metal to a low temperature (70-400°C) vapor flux, semiconductor nanowires grow at the grain boundary network in the metal. Removing the metal film with standard etching techniques, results in a free-standing, well-defined nanowire network. Size, length, density and composition of the nanowire network can be precisely tailored by the method and are less sensitive to flux parameters.

This technology has potential applications not only for battery electrodes, solar cells, or similar electric components, but may also be used to enhance the mechanical stability of materials and surfaces:

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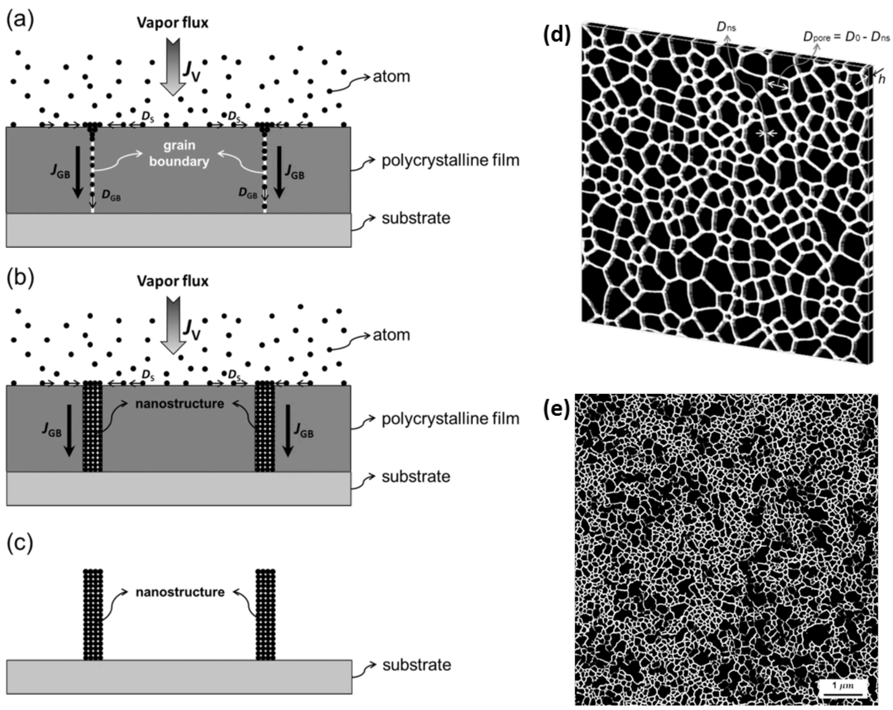

Figure 1: (a-c) Low temperature growth of semiconducting nanostructures at the grain boundaries of a thin polycrystalline metal film. (d) Schematic illustration of a nanowire network fabricated by this method featuring high and uniform pore density. (e) SEM image of an exemplary nanowire network fabricated by this method.

For example reinforced metallized polymer films can be created, e.g., for the packing industry, or surfaces with improved anti-scratch capabilities can be generated based on this technology. Furthermore, the freestanding nanowire network generated based on this technology can serve as a nanoporous membrane with ultrahigh nanopore density (see Fig. 1(d, e)) which is suitable for applications e.g. in filtration devices.

Advantages

Novel method for fabrication of nanowires and nanowire networks:

- highly scalable for industrial application
- low processing temperature from 70 - 400 °C
- compatible with existing equipment in semiconductor industries, e.g. vacuum evaporation, chemical vapor deposition, sputtering growth systems

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- robust fabrication of nanostructure tailored in length, size, composition, and density on the substrate
- wide range of applications possible (battery electrodes, filtration devices, reinforced metallized polymers …)

Patent Information

- Priority patent WO 2014037380 A1
- national patents pending in EP, US, and CN

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