”Nanotrees” for Efficient Solar Cells

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Semiconductors are insulating materials which electrical properties can be engineered. Because of this they are widely used in electronics, light-emitting diodes (LEDs), lasers, and solar cells. Commercial solar cells available today are based on silicon (Si). To improve the efficiency of solar cells, researchers are looking into other materials to make them from, but the problem is that these materials can be very expensive. Making the solar cells out of nanowires reduces the material needed drastically, while still being able to absorb similar amounts of sunlight.

Nanowires are rod-like structures with diameters ranging from 10 to 200 nm and lengths of several μm, making them roughly a thousand times narrower than a strand of hair. Their small diameters make them essentially one-dimensional, and allows for mixing of materials that do not fit with each other in larger structures. Many semiconducting materials are crystalline, meaning the atoms in the material are arranged in a very specific order. Nanowires are made up of a single crystal, where *all* the atoms are arranged in the same way along the wire. Nanowires have been the subject of a lot of recent research, and for many materials good control over shape, and how the atoms are ordered, has been achieved.

In this project we wanted to grow nanowires with the material InAsSb, which is made up of Indium (In), Arsenic (As), and Antimony (Sb). It is a very promising material for both efficient solar cells and infrared light (IR) sensors, but it is difficult to grow and control. We also wanted to grow branches on our nanowires, forming small ”nanotrees” (see Fig. 1). The branches increase the area of the nanowires, which means each nanowire can absorb more light. By using ”nanotrees” instead of just straight nanowires we can potentially increase the efficiency and sensitivity of solar cells and IR-sensors, respectively.

Nanowires are commonly grown from gases containing the desired atoms, in this case In, As, and Sb. Typically, small gold particles are used to control where the nanowires grow by collecting the atoms from the gas. The temperature and the ratios of the different atoms collected by the gold particles affect how the atoms arrange themselves in the nanowire. The growth itself works similarly to how frost is formed when water vapour in the air freezes on something solid, e.g. a tree. To grow branches on the nanowires new gold particles are put on the nanowire trunks, and the nanowires are introduced to another round of gases with atoms.

We were successful in growing InAsSb ”nanotrees”, but found that it is difficult to control how the atoms arrange themselves, especially in the branches. When more research is done on this material, it should be possible to control the ”nanotrees” better, and we are optimistic about its future potential in both solar cells and IR-sensors.

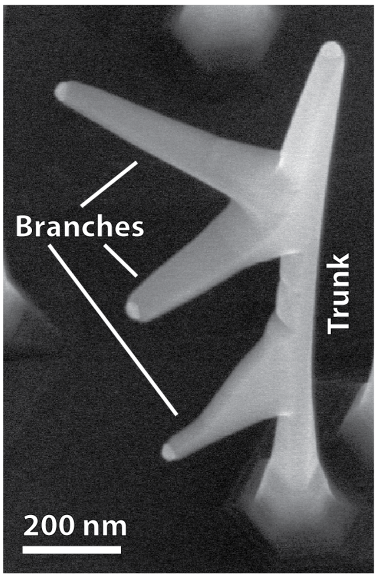

Fig. 1. Scanning Electron Microscopy image of a branched ”nanotree”. The trunk and branches are marked in the image.