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Make Semiconductors Better by Adding Bismuth

Have you wondered what is inside our everyday electronic devices? Computers and cell phones, all consist of a lot of elementary electronics, like diodes and triodes. Consider a device as a building, then diodes and triodes are like walls. Let's understand deeper to know what the bricks are. Diodes and triodes are manufactured by semiconductors, whose electronic properties could determine the performance of electronic devices, just like how essential the bricks are to a building. Currently silicon is the most common "brick" type.

III-V semiconductor materials have many better properties than silicon, such as high electron mobility which determines how fast the electronics can work. Among all III-V semiconductor materials, indium antimonide (InSb) has the largest electron mobility and it is exactly the material we study here. However, the properties need to be modified in order to fulfill the need of applications. One trick to do this is adding bismuth (Bi) onto the surface of InSb. Bi can make a difference to the original InSb surface structure and thus act like a magic potion to improve the properties and even lead to novel properties. Therefore, it is crucial to know what is happening on the Bi-incorporated InSb surface.

The aim of this project is to investigate how atoms are arranged on the surface, and which of them are bonded to each other. This study helps to understand the most fundamental issues and can support creating better "bricks" for electronic devices. Here in this research, we evaporate the bismuth atoms and blow them onto the surface of InSb. Then Bi atoms stack and grow on the InSb surface and make a difference. Then we study the surface properties with cutting-edge characterization methods.

We find that Sb atoms on the surface are bonded to the added Bi atoms and study the surface structures. This study can help to improve the performance of infrared detectors, high-speed field effect transistors, spintronics, and topological superconducting quantum devices.

In the future, we can investigate the process more thoroughly to see the Sb-Bi structure. What's more, we can do Bi deposition on InSb nanoplates and nanowires. In addition, we can introduce more characterization methods, as well as computational simulations.

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Master's project in physics 60 hp 2023
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