Researcher discovers how to control semiconductor nanowires

Jorden van Dam, researcher at the Kavli Institute of Nanoscience Delft (Holland), has succeeded in largely controlling the transportation of electrons in semiconductor nanowires. Van Dam moreover discovered how to observe a divergent type of supercurrent in these wires. Nanowires have superior electronic properties which in time could improve the quality of our electronics.

During his PhD research, Jorden van Dam focused on semiconductor nanowires. These are extremely thin wires (1-100 nanometers thick) made of, for example, the material indiumarsenide, which has superior electronic properties. The integration of these high quality nanowires with the now commonly used silicium technology offers intriguing possibilities for improving our electronics in future. According to Van Dam, in recent years many possible applications for semiconductor nanowires have emerged, such as in lasers, transistors, LEDs and bio-chemical sensors. Philips is one of the companies that is conducting intensive research into the possibilities for semiconductor nanowires in specific applications.

Van Dam - who during his PhD research co-authored articles that were published in *Nature* and *Science* - was able to make a so-called quantum dot in a semiconductor nanowire (this is done at extremely low temperatures). These quantum dots can be regarded as artificial atoms and in the distant future will serve as building blocks for super-fast quantum computers. In a quantum dot, a number of electrons can be 'confined'. The magnificence of Van Dam's research is the total control he has managed to gain over the number of electrons that can be confined in a quantum dot. He can control this number by means of an externally introduced charge.

A crucial factor for the extreme degree of control that Van Dam has achieved is the quality (for example the purity) of the nanowires, which were supplied by Philips. It is above all the quality of the material used (wires and electrodes) that was greatly improved during Van Dam's research.

The research also produced new physical observations. In the improved nanowires, Van Dam achieved for the first time the realisation and observation of a (theoretically already predicted) divergent type of supercurrent (a supercurrent is the current that occurs in superconductivity). In a quantum dot, the electrons normally pass through one by one. In superconductivity, the passage of electrons occurs in pairs. Van Dam, with the help of superconductor electrodes, has now achieved a supercurrent in the quantum dot, whereby the pairs of electrons pass through one by one.

Van Dam has also - under specific conditions - achieved a reversal in the direction of the supercurrent. He is able to control this reversal by varying the number of electrons confined in the quantum dot. With this, the Delft University of Technology researcher has achieved a largely controllable superconductor connection in semiconductor nanowires.

On Tuesday, June 13, Van Dam will receive his PhD degree at Delft University of Technology based on this research.

Source: Delft University of Technology