New superconductive properties discovered in old sandwich material

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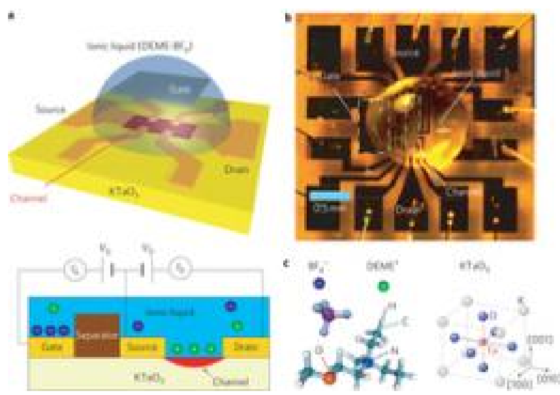

Image: *Nature Nanotechnology* (2011) doi:10.1038/nnano.2011.78. For more details, please see the original paper.

(PhysOrg.com) -- Japanese researchers, led by Masashi Kawasaki, have discovered that a previously known kind of double layered material created using electrostatic doping can be used as a superconductor.

The team, working out of Tohoku University, found that by creating a double layered material using an ionic liquid atop a platform of potassium tantalum oxide ($KTaO_3$) with deposited electrodes, a superconductive state could be made to exist by cooling the result to near absolute zero. They have published their results in *Nature Nanotechnology.*

The authors are quick to point out that they have not created a new superconductive material, but have instead figured out a way to make a known material become superconductive by means of electrostatic doping (using electrostatic properties to control the conductivity of a material). They contrast this with more traditional methods that use chemical doping (adding chemical impurities to a substance to allow for controlling the amount of current that passes through it) which they say means a material might be found that would allow for superconductivity at room temperatures; the holy grail, or course, for many researchers for many years.

The first part of the process, which had already been established, works by adding a drop of ionic liquid onto a set of electrodes that have been placed on a base of $KTaO_3$. Doing so causes a double layer to form between the materials with a gap between them of approximately 2nm. When electricity is sent to the electrodes, the charge adheres electrostatically to either side of the gap, creating a sort of capacitor. The next part is new; this is where the team subjected the result to lowered temperatures, measuring the conductivity across the gap as they went. They found that as things got colder the conductivity changed; first, from that of an insulator, then to that of a metal, then to a semiconductor and finally, to that of a superconductor, at around 0.005K, very close to absolute zero.

If the research team is successful in a finding another material that would provide the same results at room temperature they would set the stage for a whole new generation of electronic circuits that would be able to operate with very little power and produce little to no heat; options that would likely open the door to new and exciting types of computers and other types of electronic devices.

More information: Discovery of superconductivity in KTaO3 by electrostatic carrier doping, *Nature Nanotechnology* (2011)
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Superconductivity at interfaces has been investigated since the first demonstration of electric-field-tunable superconductivity in ultrathin films in 19601. So far, research on interface superconductivity has focused on materials that are known to be superconductors in bulk. Here, we show that electrostatic carrier doping can induce superconductivity in $KTaO_3$, a material in which superconductivity has not been observed before. Taking advantage of the large capacitance of the self-organized electric double layer that forms at the interface between an ionic liquid and $KTaO_3$, we achieve a charge carrier density that is an order of magnitude larger than the density that can be achieved with conventional chemical doping. Superconductivity emerges in $KTaO_3$ at 50 mK for two-dimensional carrier densities in the range 2.3×10^{14} to 3.7×10^{14} cm^{-2}. The present result clearly shows that electrostatic carrier doping can lead to new states of matter at nanoscale interfaces.