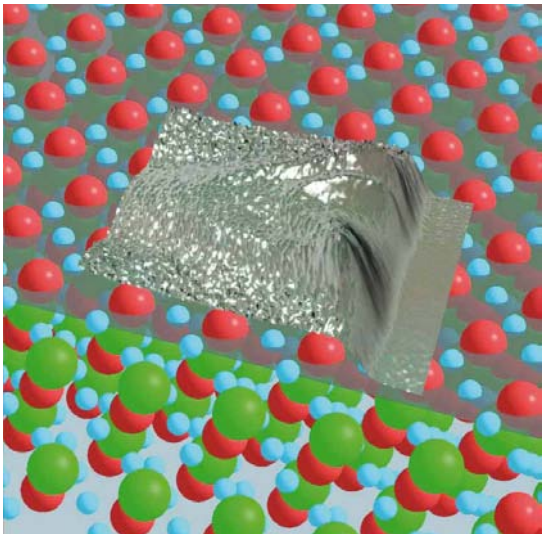
MICROELECTRONICS

New generation of transistors

Chips everywhere! In computers, mobile phones, bank cards, game consoles... integrated circuits or "chips" are in everything, and their ever-increasing performance in just a few decades has made it possible to reduce the size while increasing the power of everyday objects. In this race for the "always smaller, always more versatile," there is a great deal of active research. On the CASSIOPEE beamline a material is being studied whose properties suggest its use in a wide range of applications far beyond those of conventional transistors.



G. Sordi (ILL) et A.F. Santander-Syro (CSNSM)

3D view of dispersion E = f (k) (binding energy vs. wave vector) of electronic states of two-dimensional electron gas, as measured by angle-resolved photoemission spectroscopy, and the crystal structure of $SrTiO_3$.

Set on a square of silicon the size of a fingernail, a "classic" chip consists of millions of interconnected transistors, like so many electronic switches, using the binary language, 0 / 1. In the past ten years a new approach is being explored by scientists in order to diversify the functions performed by the components. In this context, transition metal oxides are candidates with interesting physical properties. These include magnetoresistance (related to electrical resistance, it is used in the read heads of hard disks) and thermoelectric properties (to convert heat into electricity). Strontium titanate ($SrTiO_3$), a transparent and insulating material, is one of these oxides. Experiments carried out, notably by the A.F. Santander-Syro group (CNRS – Univ. Paris-Sud 11), on the CASSIOPEE beamline have just shown that by breaking a piece of $SrTiO_3$ under vacuum, a two-dimensional electron gas is formed on its surface. The presence of this gas with metallic characteristics, which is simple and inexpensive to obtain, allows us to envisage the development of new devices combining the intrinsic properties of this material and the electrical conduction properties of electron gas. When can we expect non-volatile memory sticks in $SrTiO_3$, or transparent chips?.

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Reference : Santander-Syro, A. F. et al. "Two-dimensional electron gas with universal subbands at the surface of $SrTiO_3$". Nature, 2011, 469(7329): 189–193.

Alessandro Nicolaou, on the CASSIOPEE beamline.

Three important dates in the history of microelectronics

1 **1904 :** J.A. Fleming invented the first diode (or vacuum tube), considered as the starting point of electronics.

2 **1948 :** J. Bardeen, W. Brattain et W. Shockley, scientists at the Bell Telephone Company, invented the transistor. They received the Nobel Prize for Physics in 1956.

3 **2011 :** a "standard" transistor now measures 32 nanometers. At the beginning of the 1950s, they measured about 2 centimeters.

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