COLDFIB – The new FIB source from laser cooled atoms

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Charged particle beams of controlled energy and strong focusing are widely used tools in industry and science. Focused Ion Beam (FIB) column combine with a Scanning Electron Microscope (SEM) provide full control of nanofabrication or nanolithography processes. Ion energy can be varied typically in the 1–30KeV range, with an energy-dependent resolution attaining the nanometer range. State-of-the-art FIBs commercially available are based mainly on plasma, liquid metal tip or helium ion sources for large, intermediate, and low currents, respectively. Despite the very high technological level of the available machines, research of new ion sources allowing even higher resolution and a wider choice of atomic or molecular ions for new and demanding application is very active.

As an example, the world of electronic components evolves regularly towards the miniaturization by integrating a number of transistors more and more important. The dimensions being smaller and smaller (technology 10 nm, 7 nm even 5 nm), nowadays the instruments of analysis used, like the conventional FIB, reach their limit. Thus it's necessary to realize a technological breakthrough to be able to observe, analyze and modify components and structures on the scale of the nanometer.

Our new system, COLDFIB, wants to take up this challenge of the nanomanufacturing by the coupling of two high technologies: the laser cooling of atoms, and manipulation of charged particles.

Very innovative, this industrial solution, based on a source of ions obtained from atoms laser cooled and ionized, will allow realizing ions beam in the unequalled performances, to reach engraving's sizes of some nanometers. This new technology offers a resolution, for example at 5KeV, 10 times better than the LMIS one, and reaches the nanometer at 30keV *(Figure 1)*.

We'll present in this talk the integration on the SEM-FIB TESCAN instrument. In addition to the experimental[1] part and performances[2] will also show some first applications.

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[1] L. Kime, et al., *High-flux monochromatic ion and electron beams based on laser-cooled atoms*, Phys. Rev. A 88, 033424 (2013)

[2] M. Viteau, et al., *Ion microscopy based on laser-cooled cesium atoms*, Ultramicroscopy (2016)

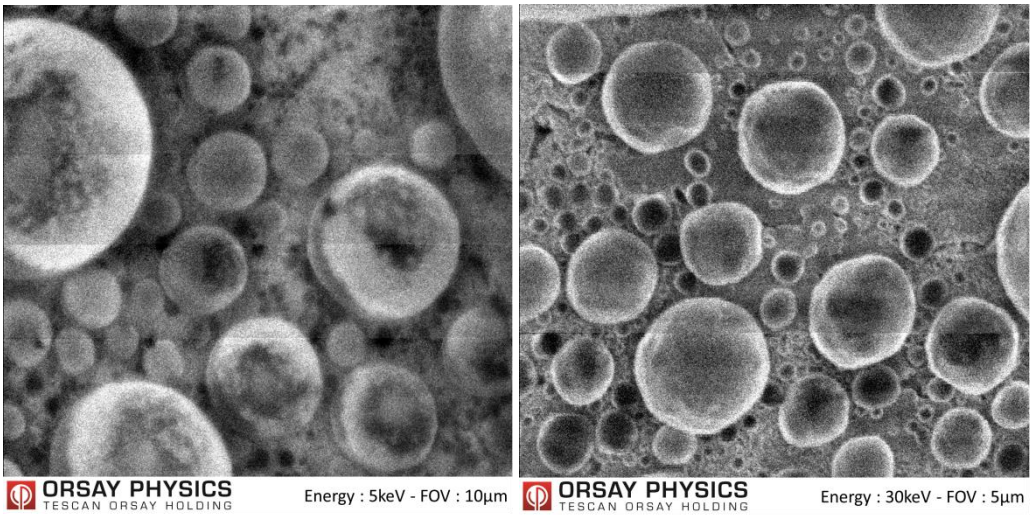

Figure 1: Tin on carbon sample: Example of images obtained with COLDFIB at 5keV and 30keV, with a different field of view, respectively 10 and 5µm.