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Counting Atoms in Nanomaterials (COUNTATOMS)

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Advanced electron microscopy for solid state materials has evolved from a *qualitative* imaging setup to a *quantitative* scientific technique. This will allow us not only to probe and better understand the fundamental behaviour of (nano) materials at an atomic level but also to guide technology towards new horizons.

The installation in 2009 of a new and unique electron microscope with a real space resolution of 50 pm and an energy resolution of 100 meV will make it possible to perform unique experiments. We believe that the position of atoms at an interface or at a surface can be determined with a precision of 1 pm; this precision is essential as input for modelling the materials properties. It will be first applied to explain the fascinating behaviour of multilayer ceramic materials. The new experimental limits will also allow us to literally count the number of atoms within an atomic column; particularly counting the number of foreign atoms. This will not only require experimental skills, but also theoretical support.

A real challenge is probing the magnetic and electronic information of a single atom column. According to theory this would be possible using ultra high resolution. This new probing technique will be of extreme importance for e.g. spintronics. Modern (nano) technology more and more requires information in 3 dimensions (3D), rather than in 2D. This is possible through electron tomography; this technique will be optimised in order to obtain sub nanometer precision.

A final challenge is the study of the interface between soft matter (bio- or organic materials) and hard matter. This was hitherto impossible because of the radiation damage of the electron beam. With the possibility to lower the voltage to 80 kV and possibly 50 kV, maintaining more or less the same resolution, we will hopefully be able to probe the active sites for catalysis.