Nanotechnology in school

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Matthias Mallmann from NanoBioNet eV explains what nanotechnology really is, and offers two nano-experiments for the classroom.

Nanotechnology has become a popular buzzword in science and politics. This key technology is considered not only a major source of innovation in technology, medicine and other fields, but also one of the main challenges for the 21st century. European universities and high-level vocational training programmes already cover this technology extensively. However, although the word nanotechnology will be familiar to many high-school students, the subject is not widely taught in European schools. This article outlines several initiatives to increase awareness of nanotechnology among European science teachers, and details two nanotechnology experiments for the classroom.

What is nanotechnology?

Nanotechnology is not really anything new. It deals with entities and processes on the scale of 10^{-9} m (1 nanometre), which is the dimension of molecules and atoms — a scale that chemists, biochemists and cell biologists have worked with for centuries.

At the nanoscale, the properties of a material may change. For example, hardness, electrical conductivity, colour or chemical reactivity of minuscule particles of materials are related to the diameter of the particle. Specific functionalities, therefore, can be achieved by reducing the size of the particles to 1–100 nm.

A well-known application of early nanotechnology is the ruby red colour that was used for stained glass windows during the Middle Ages (see image). The colour is a result of gold atoms clustering to form nanoparticles instead of the more usual solid form. These small gold particles allow the long-wave red light to pass through but block the shorter wavelengths of blue and yellow light. The colour, therefore, depends both on the element involved (gold) and on the particle size; silver nanoparticles, for example, can give a yellow colour.

What is new, though, is the multidisciplinary approach and the ability to ‘look’ at these entities. The atomic force microscope, which was developed in the late 1980s, allows scientists to view structures at a nano-metric scale and to handle even single atoms via scanning probe microscopy. Now biologists can discuss steric effects of cell membranes with chemists, while physicists provide the tools to watch the interaction *in vivo*. Nanoparticles play an important role in the pharmaceutical industry (delivering active agents to the required part of the body) in the production of emulsion paint and cosmetics and in the optimisation of catalysts. Nanotechnology, therefore, has combined all natural sciences and creates cross-links between the different disciplines.