Nanotechnology Highlight

Counting individual charged molecules and nanoparticles one by one.

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For someone making a product, being able to see it is often a pressing necessity. But how do scientist and engineers building structures whose dimensions are only a few nanometers manage to see what they are doing? Electron microscopy (EM) is a powerful tool at their disposal. But using it on single particles one or a few nanometers in diameter is no easy task, not even when they are deposited on the clean and flat surface of a perfect crystal. Consider then how hard it would be to monitor such small entities on the fly, while they are being made by gas or liquid phase reactions. For this reason, alternative means to "see" individual objects with nanometer dimensions have been highly sought. A widely used approach consists on suspending such particles in an atmosphere well above 100% humidity, whereby the water vapor condenses on the particles and turns them into much larger drops which can actually be seen by eye or electronically. Instruments capable of performing this size magnification and optical detection have been known for about a century, and are called Condensation Nucleus Counters (CNCs). Unfortunately the most advanced CNCs available commercially have been capable of detecting only objects with dimensions larger than 3 nm. This is excellent for many applications in nanotechnology. But it is insufficient for others. For instance, Japanese Scientists have been working at controlling the color displayed by computer monitors and other devices by tayloring the size of nanometer sized particles. When this technique is based on well developed silicon technology, this color control becomes available only below 3 nm. Those interested in this and other processes requiring an ability to detect such small particles will welcome a recent report from Yale's Engineering Department (Gamero-Castaño, M. and Fernandez de la Mora, A condensation nucleus counter (CNC) sensitive to singly charged subnanometer particles; J. Aerosol Sci., **31**, 757-772, 2000). These authors have just developed the first CNC capable of detecting individual nanoparticles with no lower size limit, including small molecular objects of subnanometer dimensions. The only special requirement other than a well-designed instrument is that the particles be charged, but this is often the case. The apparent reason why such small particles had never been seen in other CNCs is the lack of instrumentation able to produce them of a single. Once the appropriate instrumentation to do so was developed in their laboratory, the rest became relatively straightforward. This innovation was sponsored by the National Science Foundation, and is currently used to facilitate another NSF project at Yale with the goal of making dense materials from nanometer particles without the need to compact them thermally or mechanically from originally fluffy structures. This project is lead by Professor D.E. Rosner and involves faculty from the chemical and Mechanical Engineering Departments.

Submitted by Juan Fernandez de la Mora
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