Three-dimensional atomic-scale structure of size-selected gold nanoclusters.

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Poster by Rajiv Thakrar

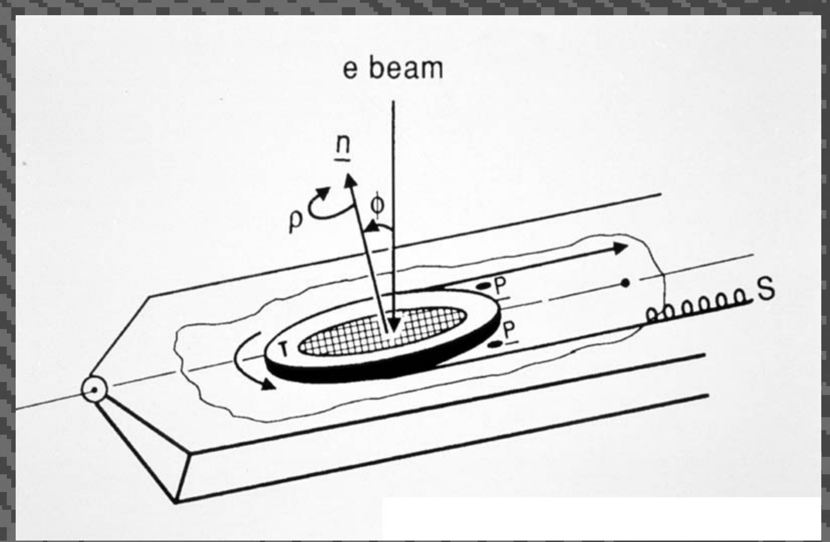
Introduction

This experiment explored the three-dimensional shape, orientation and atomic arrangement of gold nanoclusters Scanning Transmission Electron Microscopy (STEM). It was found that this technique could be used for to find specific isocahedral, ino-decohedral and cubohedral shapes.

Experimental Method and Techniques

When studying stable and stationary particles, a technique known as electron tomography is usually used.

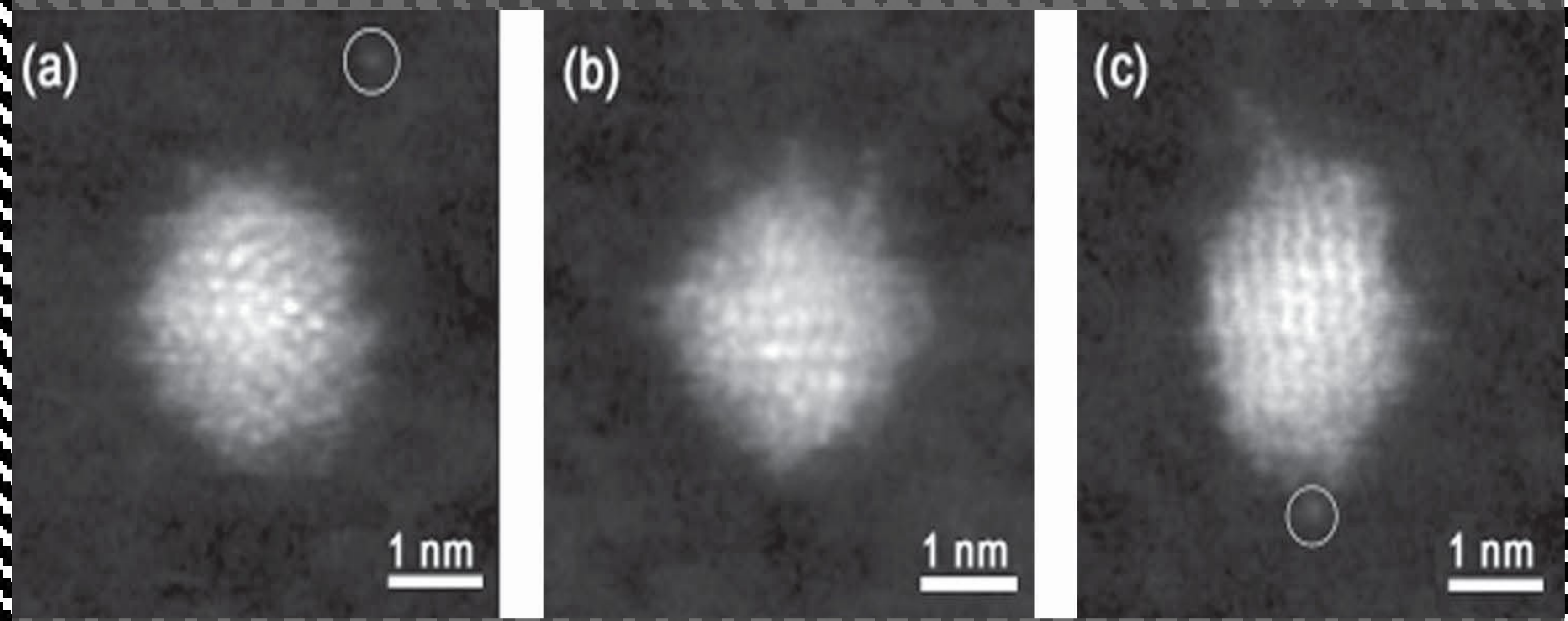
A Scanning Transmission Electron Microscope.



A diagram of how electron tomography works, where an electron beam is deflected off a material.

This technique is usually too powerful for the nanoclusters as are structurally unstable, and hence broke down under dense electron beams. So a technique called scanning transmission electron microscopy (STEM). This field achieves atomic resolution of images using electron beams that are transparent enough to avoid the breakdown of the nanocluster structure.

This method of collecting images is appealing as the images obtained from the apparatus have varying intensities which show distinction between individual atoms. High resolution transmission electron microscopy typically uses phase contrast, which requires computer simulation to create a suitable image. The method is more direct, and is also appealing as it allows the number of atoms in a column to be observed accurately.

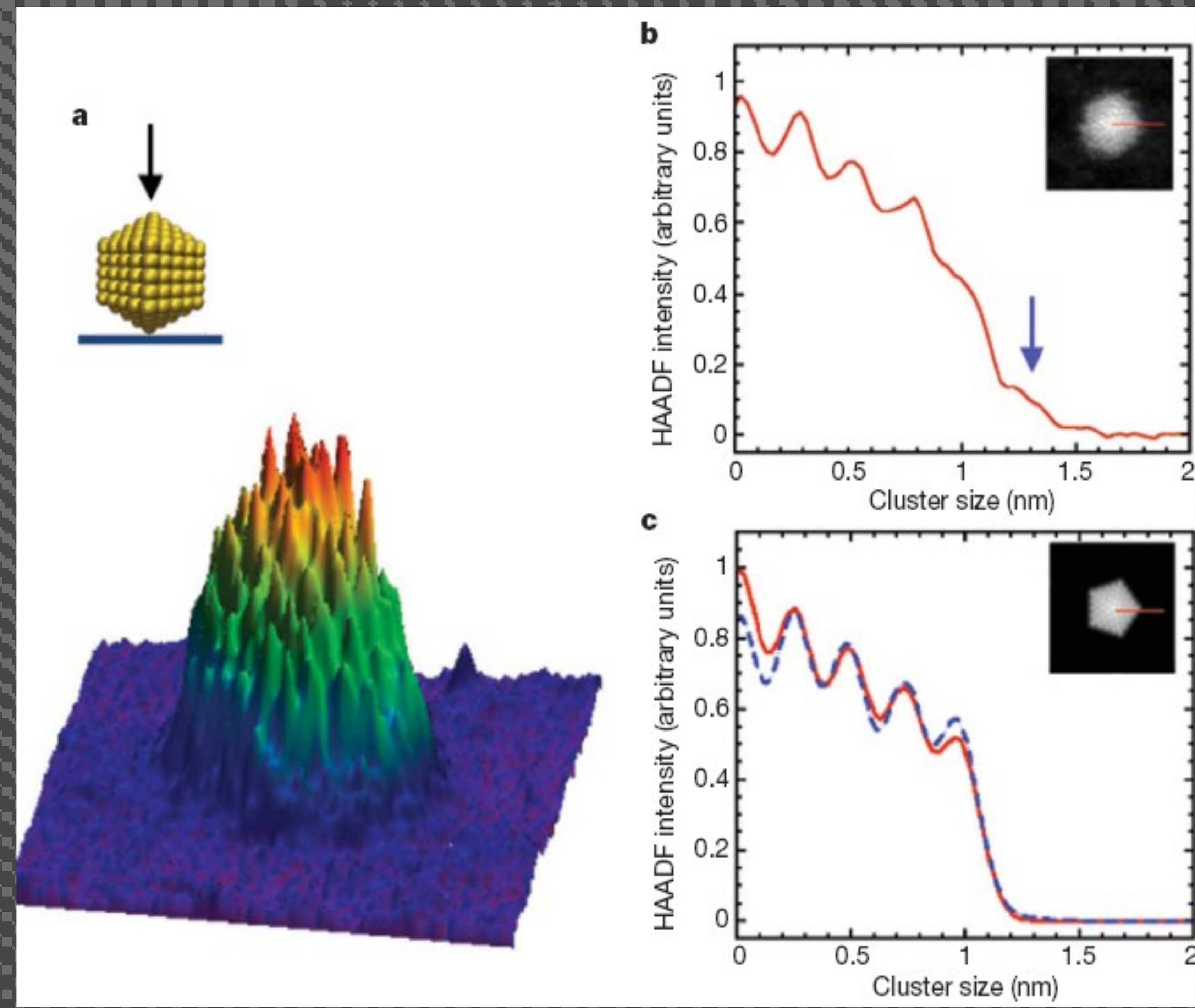


High resolution images of gold nanoclusters.

Results

It was found that a detailed structural and stability analysis of size-selected metallic clusters could be obtained using this method, being consistent with predicted results. Increased fluctuations and motion of the surface atoms of the cluster were also found. This may be due to an intrinsic property of the gold clusters that could be related to their catalytic properties. Techniques used in this investigation may allow routine three-dimensional structural characterization tool for small nanoparticles at the atomic-scale level.

A closer inspection of the intensities found gave rise to the atomic structure of the clusters. High resolution images of intensity showed various shapes of the nanoclusters (seen in the image above).



The image above shows: the Three-dimensional atomic structure of a gold cluster (*N*530966); a Three-dimensional atom density profile of Au309; an experimental intensity line profile taken from the central atom column of the cluster to one of the corners; and an intensity profile (solid curve) across one ridge (indicated in inset with red line) is compared with the result from a full dynamical multislice calculation (dashed line).

The technique used to gain imagery of the particles was found not harm their intrinsic structure, signifying the potential for this method to be used for imagery of other small metallic particles.