interactions to be explored) in parallel under identical conditions. The use of one or more reference cantilevers in the array — that is, cantilevers that have been passivated to prevent ligands binding to them — enables differential measurements and quantitative determination of the binding constants for various interactions (see Fig. 1a of the article by McKendry and colleagues[5]). It has been known since the mid-1980s that bacterial resistance in *Enterococci* can arise because a single hydrogen bond is deleted[7] from the binding pocket (see Fig. 1c in ref. 5), and this very subtle effect has now been clearly recognized in experiments using cantilever technology for the first time.

McKendry and co-workers investigated in a quantitative way the interactions of the antibiotic vancomycin with cantilevers that had been coated with an amino acid sequence (lysine-D-alanine-D-alanine) that occurs naturally in mucopeptides in the cell walls of bacteria. Vancomycin binds to the carboxy-terminus of a mucopeptide containing this amino acid sequence, hampering cell-wall synthesis by introducing weak points into the wall and eventually leading to the death of the bacterial cell[7–9]. These measurements are compared with measurements made with cantilevers coated with a mucopeptide from bacteria that are resistant to vancomycin. The data shows that vancomycin has different binding constants and causes different surface stress with each mucopeptide.

The team suggest that changes in the surface stress cause mechanical disruption of both the bacterial membrane and the cell wall, which eventually leads to the destruction of the bacteria. The observed compressive stress on the surface of the cantilever is interpreted as a product of a local chemical binding factor and a geometrical factor describing stress transduction as a collective phenomenon. Therefore, for mechanical disruption to occur, a relatively large fraction of the surface needs to be covered with vancomycin to establish connectivity between the weak points in the cell wall.

Investigating the mechanical influence of the antibiotic on the bacterial cell wall, as well as measuring binding properties, could result in the development or discovery of more potent antibiotics. And given the ability of bacteria to continually evolve to remain resistant to antibiotics, it will be necessary to understand the interactions between antibiotics and bacteria at the most fundamental level if we hope to keep superbugs at bay.

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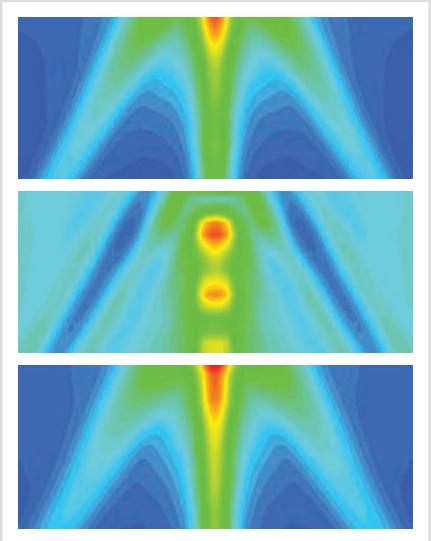
X-RAY DIFFRACTION

Catalysis live

Metal nanoparticles dispersed on a surface act as catalysts for the synthesis of many industrial chemicals and fuels. For such catalysts, the relationship between structure and properties is delicately poised, and so far most fundamental insights have come from experiments on model catalysts, such as single-crystal surfaces in controlled environments. However, real catalysts are inherently more complex, and their size, shape and surface structure can also change during a reaction. Andreas Stierle and colleagues at the Max Planck Institute for Metals Research in Stuttgart and the CEA Institute for Nanoscience and Cryogenics in Grenoble have now shown that changes to rhodium nanoparticles during the course of a reaction can be followed directly by using high-resolution X-ray diffraction (*Science* **321,** 1654–1658; 2008).

Stierle and co-workers examined the rhodium nanoparticles, which were supported on a magnesium oxide surface, during oxidation and reduction reactions. To obtain atomic-scale information on the average shape and size of the nanoparticles, they recorded reciprocal-space maps at elevated temperatures and under various gas atmospheres. From the analysis, the particles were found to have a truncated pyramidal shape. The figure shows fitted diffraction maps for the (110) plane of the clean rhodium nanoparticles (top) and the oxidized nanoparticles (bottom), and the difference between the two (middle). The ridges pointing towards the bottom corners correspond to (111) facets at the side of the nanoparticles, whereas the ridge running down the centre corresponds to a (001) facet at the top of the nanoparticle. The signal intensity (top and bottom) and the difference in intensities (middle) are represented by the spectrum of colours, running from blue (low) to red (high).



The researchers found that the addition of oxygen led to flatter nanoparticles: this can be seen in the difference map — the intensity is increased along the (001) ridge and decreased along the (111) ridge. However, this change could be reversed by exposure to carbon monoxide. Complementary information about the shape of the nanoparticles was also obtained with transmission electron microscopy. Stierle and colleagues showed that this reversible change of shape was driven by the formation of an oxygen–rhodium–oxygen surface oxide trilayer at the facets of the nanoparticle.

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