THE SUNDAY TIMES, 25 MARCH 1984

innovation

Digging below the surface

A TEAM of German and Israeli scientists has announced a revolution in our understanding of how smooth or rough surfaces are. This will have implications for many industrial chemical processes which use catalysts.

These include many operations in the petroleum and petrochemical industries.

The importance of research into surfaces is that catalysis takes place on the surface of the catalyst. The latest results introduce a completely new approach to chemistry, which may resolve riddles about how materials interact.

The work had been done by Dr David Avnir and Dr Dina Farin at the Hebrew university of Jerusalem, and Dr Peter Pfeifer of Bielefeld university in Germany. Their discoveries are based on the concept of fractal geometry, which has only been known since 1975. The word "fractal" was invented by an extraordinary thinker called Enoit Mandelbrot, an IBM research fellow, who put forward the theory that natural objects have forms which cannot be adequately described by conventional geometry.

We are all taught at school that a line has one dimension, a plane has two dimensions, and an object has three dimensions. But that will not do, Mandelbrot insisted. Real things have fractional dimensions which fall between one, two and three, he said. The new studies have confirmed these bizarre notions.

It may seem crazy to talk of a dimension which is only partial, or fractional. But that is Mandelbrot's special insight – that real things are never ideal. Nothing that really exists is ever exactly one, two or three dimensional. All matter strains to be perfect, but it never succeeds. Thus, all real surfaces are two dimensions *plus*. And the more *plus* they are, the rougher textured they are.

The traditional way of thinking is to view all real surfaces as ideal surfaces which just happen to be a bit of a mess. But Mandelbrot said we have to get the ideal flat surface out of our minds and be more realisitic. Once we do that, we can see what is really staring us in the face – that what looks like a mess is really a new kind of order which we have overlooked.

Studied more carefully, the majority of these messy surfaces turned out to have a property of being what Mandelbrot calls "self-similar".

That is, as you look at them with greater and greater magnification, you see that their wiggles and contours are repeating in the same characteristic pattern at smaller and smaller sizes. It is as if one studied the individual lines in a man's fingerprints and discovered through a powerful microscope that each line consisted of the same whole fingerprint repeated endlessly in line, a true world-within-a-world, leading to an infinite regress.

The key to the maze is that the rate and manner in which these seemingly messy surfaces repeat their newly discovered secret patterns, can be expressed by a single number computed from fairly simple equations. This brings sense out of nonsense in a miraculous fashion. Take the number 2 (for the two traditional dimensions of the plane) and add a decimal after it to represent the characteristic degree of roughness of the material, and this gives the material's so-called "fractal dimension". For instance, Avnir, Farin and Pfeifer have computed the "fractal dimension" of the extraordinarily smooth substance, graphite, as 2.07.

But silica gel's 'fractal dimension" is nearly three, for its surface is so fantastically convoluted. The endless crevasses which silica gel's surface offers enable water molecules to become trapped easily, giving silica gel its water absorption capacity.

This is one example of how the new discoveries can help us understand what goes on when molecules come up against surfaces. The scientists have now begun researching the fundamental process of catalysis. Their discoveries could have important economic consequences.

Robert Temple

Beast in the brain

NEW proof has been found of the existence of an animal brain inside the human brain. This so-called limbic system was first indentified in 1878, and although it is thought to be responsible for many basic feelings, until now it has remained a mystery.

Dr Pat Levitt, an anatomist at the medical college in Pennsylvania has used the new tool of monoclonal antibodies to study the limbic brain. These are a kind of "magic bullet" which make their way through the body to single types of cell.

The "magic bullets" ignore all cells except those with special molecules called antigens on their surfaces. An antigen is a substance which elicits a reaction by an antibody and even if we don't know what the antigen actually is, we can detect its existence when we see it attacked by the antibody.

Levitt suspected that there would be molecules in the limbic brain which would only exist there, and not outside it. He was right. By an elaborate technique, he prepared many antibodies against a variety of brain substances at random. And one of these was the "magic bullet" he was hoping for. It went shooting straight for these hitherto unknown special molecules, and the area of brain in which they were contained turned out to be the limbic system.

Levitt has made the first identification of a system within the human brain by such molecular means. He has also made the first discovery of an entirely new type of brain molecule which is restricted only to one system and not found elsewhere in the brain. And the areas of limbic brain which he found were slightly different than the latest anatomical wisdom would have had it, so that we now can see that the limbic brain extends to certain places which are new.

What is this limbic brain? The eminent neurologist Paul MacLean said it is the part of the brain which generates the feeling of hunger, thirst, nausea, cold, warmth, fear, foreboding, sadness, and the desire to be either alone or in company. In addition, it tells us (rightly or wrongly) that we want to urinate, eat, choke, vomit, run away, suffocate, or be at ease. MacLean believed that when the limbic brain runs amok, it results in paranoia.

How do we happen to have this brain? It is basically the brain of our animal friends. Only we and the whales and dolphins have evolved the neocortex properly as a "thinking-cap" to tame and control the animal brain within us. The next time you feel a nameless dread, you can take comfort from the fact that the part of the brain from which it comes has now been proved to exist. And we may now be nearer to treatment for the sad disease of paranoia, which comes from the beast within us all.

Robert Temple