What is ‘Fractal Dimension’ of a surface and how can it be experimentally determined?

The extent of fractality of any line or surface is indicated by a statistical index called as ‘Fractal Dimension’.
In the case of line in one plane, fractal dimension indicates how much the line fills the planar surface area (2D). If we consider the lines in Figure as only lines, the fractal dimension of Line 5 will lie between 1.0 and 2.0, say 1.4.
In the case of surfaces, the fractal dimension indicates how much the fractal surface fills the spatial volume (3D). If we again consider the lines in the Figure, as cross sectional side view of a surface, then the fractal dimension of the surface indicated by Line 5 will be between 2.0 to 3.0, say 2.35.

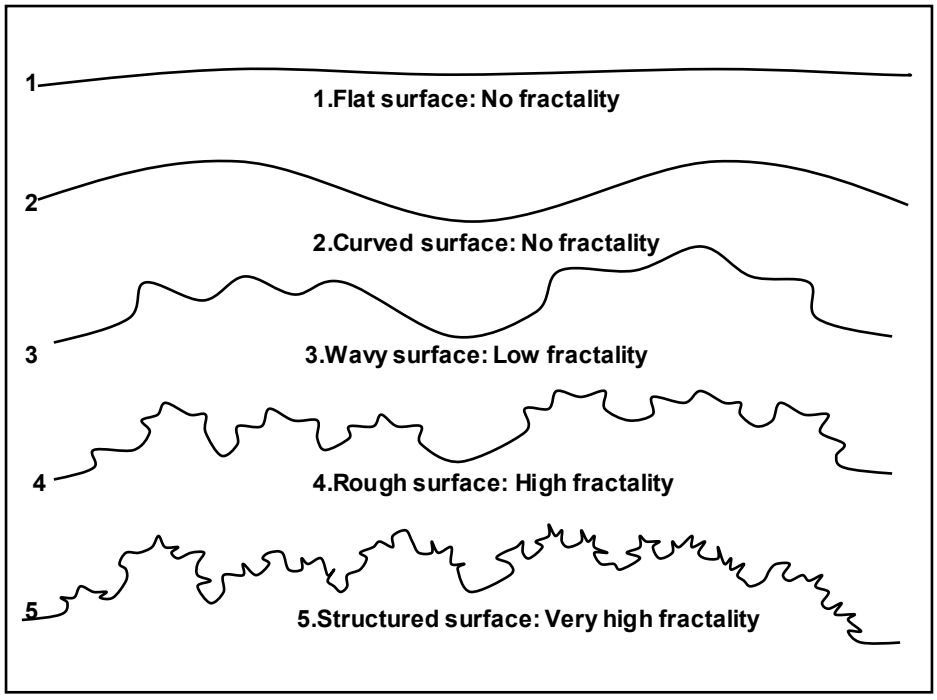

Figure: Cross sections of surfaces with increasing fractality

Importance of the fractal dimension of a surface lies in the fact that it is a single number characterizing the state of the surface. This number can be experimentally determined. The steps involved are as follows:

1. Determine the area of the surface of the test specimen employing different techniques with progressively finer resolution. Variety of techniques are available depending on the nature of the specimen. These include profile gauges, light microscopes, scanning electron microscope (SEM with varying resolution), atomic force microscope (AFM) and BET surface area. The finer the resolution of the technique, the higher is the measured surface area.
2. Large amount of data generated in the step 1 above is analyzed using computer programs. The algorithms co-relate the surface area obtained employing a given technique with the least count of that technique. The relationship is log-log linear and the line fractal dimension is computed from the slope of the line.

Thus the fractal dimension of a surface lies between 2.0 and 3.0; higher values (within this range) indicate higher level of fractality i.e. higher degree of fine structure associated with the surface.

Fractal dimension of a specimen is found to have co-relation with many interface phenomena like adhesion, adsorption, hydrophilicity, diffusion and flow.
