FRACTALS IN FRACTOGRAPHY

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There has been a considerable revival of interest recently in developing a more quantitative fractography. Most approaches seek to supplement the information available in the flat SEM photomicrograph. One of the more promising experimental procedures is to cut vertical sections through the fracture surface, generating profiles whose characteristics are related to those of the fracture surface. Thus, attention has been paid to methods for characterizing irregular planar curves.

It has been suggested lately that irregular curves (such as the coastline of Britain or the Koch snowflake) possess unusual geometrical properties. Mandelbrot postulates that the measured length $L(\eta)$ of such curves is solely a function of the size (η) of the measuring unit used to measure the length, and that the length of the curve is said to approach infinity as the size of η approaches zero. Moreover, on a log-log plot of $L(\eta)$ vs. η, there is supposed to be a perfectly straight line with slope related to the fractal dimension D.

We have also investigated the fractal characteristics of our fracture profiles. Results have been most unusual because of the unique data obtained. We have varied η between 0.683 and 426.5 μm for a series of fractured 4340 steel specimens. Instead of a straight line, these extensive data clearly reveal a reversed sigmoidal type curve with asymptotic extremes approaching zero slope at large and small η. Thus D is far from constant and varies with the size of η. More limited data available in the literature show this asymptotic behavior as two straight line segments.

The current misconceptions about fractal curves may be clarified to some extent if we separate what is known (the factual part) from what is conjectured (the fractal part). It is obvious that the apparent length of any irregular curve will vary in dependence on the size of the measuring unit. However, the assumption of self-similarity of a curve on a smaller and smaller scale is purely speculative. We know there must be a limitation on the size of η imposed by the size of the atoms; thus, further subdivision would not be possible. Finally, to generalize the slope of the reversed sigmoidal curve, we have used a linear form which yields a unique, constant value of modified fractal D.