Why Metals Grow Tired

Strange Secrets of their Crystalline Structure

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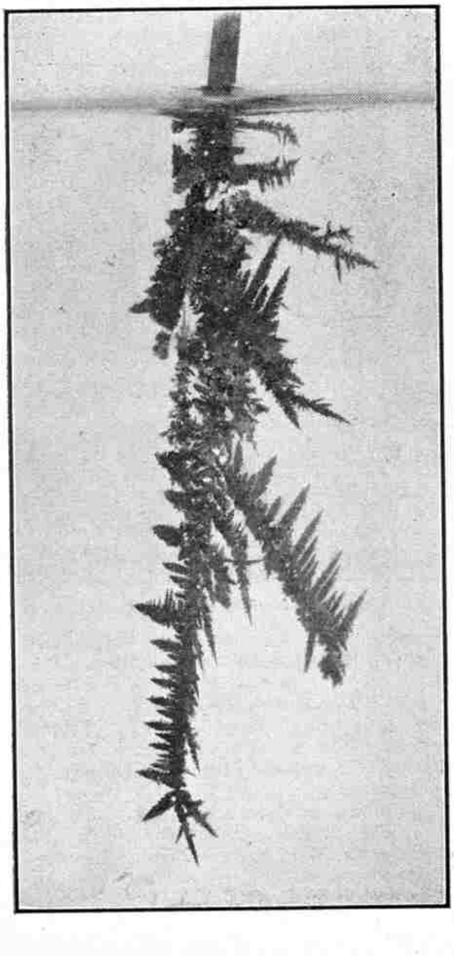
ANY one who has happened to break a piece of cast-iron and has glanced, even momentarily, at the fractured surfaces cannot fail to have noticed that the broken area has a crystalline appearance. The individual crystals are too minute to be distinguished by merely looking at the break, but when this is examined under even a low-power magnifying glass an enormous number of tiny greyish crystals can be seen. Some metals show this crystalline structure better than cast-iron. For instance, a stick of antimony, bismuth or tellurium when snapped across discloses the presence of crystals that can be recognised by the unaided eye. All metals indeed are crystalline in nature, and large pieces of them are really masses of exceedingly tiny crystals that have been very closely compacted, like the crystals in a lump of sugar.

How this "tree" of lead crystals is obtained is explained in this article.



Metals had been used for thousands of years before their inherent crystalline structure was recognised. This was brought to light in 1864, when a mineralogist named Henry Clifton Sorby began to examine metals under his microscope. For this purpose he polished their surfaces until they formed excellent mirrors and then dipped them in weak acid. This had the effect of etching the metal, that is of eating into its surface. The acid attack is not regular, some portions being eaten away by the acid more than others; and when the etched surface of a highly polished metal is washed, dried and examined under the microscope, a sort of mosaic appearance is disclosed. It did not take Sorby long to realise that the closely-patterned appearance of his specimens was characteristic of a cut across a mass of metal crystals. The acid etching solution had chiefly attacked the metal crystals at their boundaries, and thus had rendered their sectional outlines visible under the microscope. With this discovery came a flood of light upon many problems that had hitherto perplexed and vexed engineers, mechanics and metal users generally.

Nearly every known pure metal can be obtained in individual crystals by appropriate methods. For example, crystals of lead can be made by electrolysing a moderately strong solution of lead acetate or lead nitrate, using a strip of zinc or an iron nail as the negative electrode. Lead is deposited on this electrode in the form of beautiful shining tree-like crystals, which grow until they reach the bottom and sides of the electrolysing vessel. A similar "lead tree," as this characteristic crystalline formation is called, can be obtained without the aid of any electrical circuit by merely suspending a strip of well-cleaned zinc in a strong solution of lead acetate or nitrate. Its formation by this method is slower and less striking than by the electrolytic one, however.

A rod of antimony, on the left, compared with one of tin. The former has the coarser crystals and is more easily broken.

Another way of obtaining characteristic metal crystals is illustrated by melting a quantity of bismuth by heating it to a temperature of 268 deg. in a porcelain basin or crucible. The liquid is allowed to cool slowly until just after its surface has solidified, when its solid crust is pierced with a pointed instrument and the still molten metal inside is poured out. Beautiful needle-like crystals of metallic bismuth are left in the crucible. The perfection of their formation depends upon the slowness of the cooling of the metal, and the rapidity with which the remaining molten metal is poured away after the solidified surface has been punctured.

When we know that a metal consists of a mass of closely compacted crystals, we are in a position to understand what happens inside it when it becomes "tired," and when, ultimately, it fractures. Suppose that a metal bar is firmly fixed at one end, and has a heavy weight suspended from it at the other end. As the weight is increased the bar sags more and more, and finally breaks. If the weight were taken off the end of the bar as soon as bending took place, the bar would remain intact for an indefinite period. Applying the weight and removing it in quick