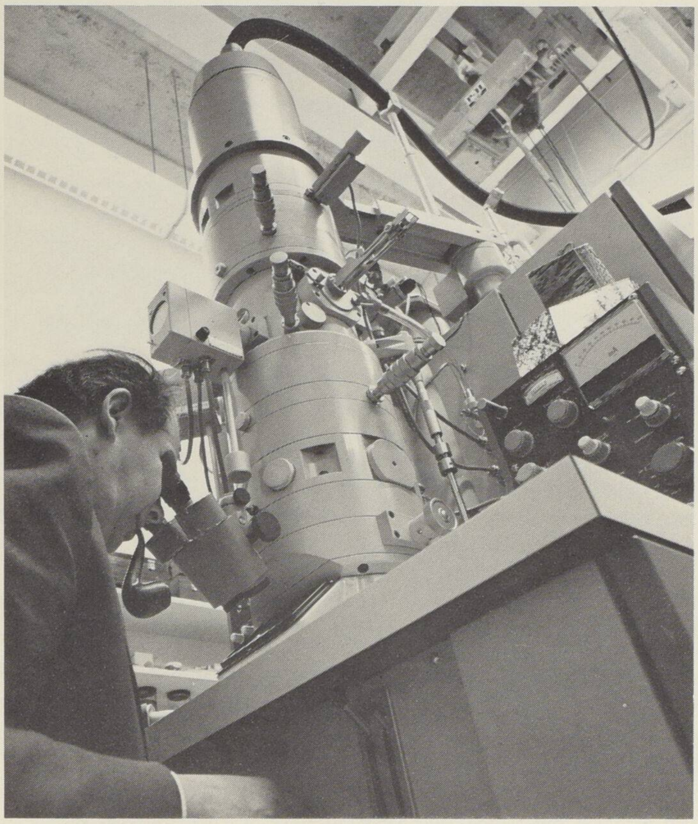

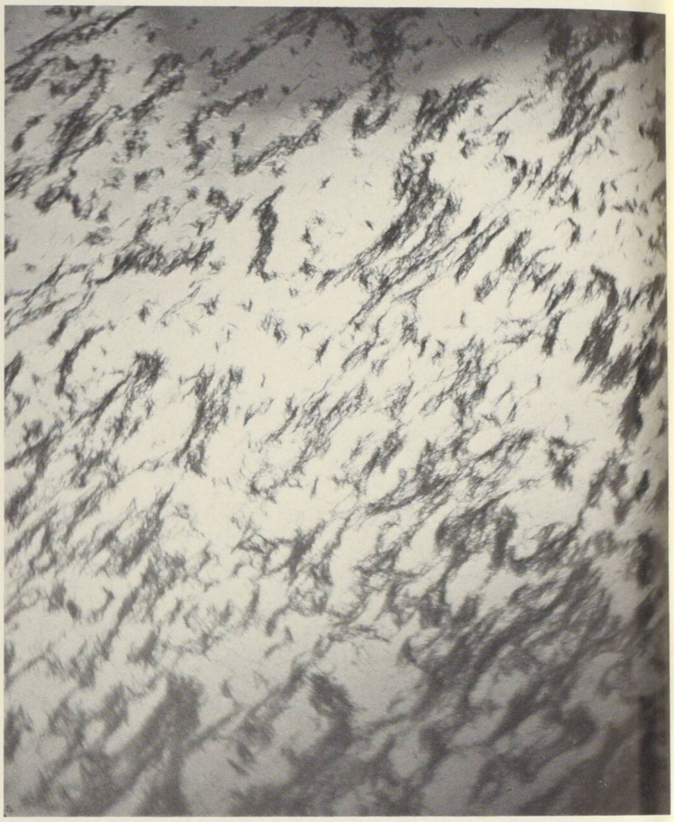

cles which will stop the dislocations from moving. This can be achieved in many ways.

For example, a blacksmith finds that an iron spike hardens after repeated hammering on his anvil. At a microscopic level, the blacksmith increases the number of dislocations enormously with every stroke. When their density in the metal is so great, the dislocations impede each others' motion like rush-hour traffic. As a result, the cold-worked metal becomes much stronger.

In the laboratories of the Metal Physics Section, researchers subject metal crystals to variations in stress and temperature while testing various mechanisms involving dislocation for different crystal structures. In addition, dislocation behavior is examined with the aid of advanced computer-modelling techniques.

"It is very important to understand dislocations," says Dr. Zbigniew Basinski. "We must learn how to impede them to obtain desired properties such as strength, but at the same time to avoid stopping them completely. That is, if we make dislocation movement impossible, the metals will become brittle leading to such results as the snapping of a steak knife or the collapse of a bridge."

Another method of hardening pure metals is through alloying. For example, when mixed with impurities of carbon or tin, the relatively weak metals iron and copper are transformed into the stronger, more rigid materials steel and bronze. Through modern technology, giant aircraft can be constructed from materials which, when pure, are so soft they can be scratched easily with a fingernail.

It is known that alloying replaces some of the atoms in the pure metal's lattice with atoms of a different kind. In effect, the foreign atoms provide obstacles to the motion of dislocations. This theory implies that both the concentration and nature of the impurity are important to its effect on hardening.

Unexpectedly, NRC physicists have found otherwise. In fact, they discover, hardening depends much more on the "solvent" or host metal than on the kind or concentration of

By focussing on dislocations (boundary lines between slipped and unslipped regions of an atom plane) in deformed metal crystals, physicists seek a more detailed theory of metal hardening. These dislocations (right) are readily visible under the transmission electron microscope as thin black lines tangled up against a clear background.

En focalisant sur les dislocations (lignes délimitant les régions qui ont glissé des autres régions dans un plan atomique) dans des cristaux métalliques déformés, les physiciens cherchent à établir une théorie plus détaillée du durcissement des métaux. Ces dislocations peuvent être examinées de près dans l'encadré grâce au microscope électronique à transmission et apparaissent comme de minces lignes noires enchevêtrées sur fond clair.

impurity. For example, copper-, gold-, and silver-based alloys behave similarly, and the hardening of each can be described by only one parameter, quite independent of the impurity added.

"It seems that the most important factor in any description is the response of a dislocation to the presence of an impurity rather than some active characteristic of the impurity itself," explains Dr. Basinski. "We hope to explain this surprising result by carrying out a major re-examination of existing alloy-hardening theories."

One further aspect to the work is a study of the fundamental mechanism of fatigue, a process by which metals often tire and eventually fail in service. Recently, the Metal Physics group has found that metals can be "trained" and that failure is aggravated by suddenly changing the conditions of deformation imposed on them. An understanding of the training process may mark an important step towards elucidating the mechanism of fatigue as well as expanding further the theorist's base of knowledge concerning the properties of metals. □

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