This Week's Citation Classic

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Stein D F & **Low J R.** Mobility of edge dislocations in silicon-iron crystals.
J. Appl. Phys. **31**:362-9, 1960.
[General Electric Res. Lab., Schenectady, NY]

The velocity of free individual dislocation in a 3.25% Si-Fe was measured as a function of stress and temperature. It was found that a lattice resistance to the motion of dislocation existed that increased with decreasing temperature, explaining the increase in the yield stress of BCC with decreasing temperature. [The *SCI*® indicates that this paper has been cited over 290 times since 1961.]

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"The research leading to the paper was performed while a member of a chemistry-metallurgy training program of the General Electric Company. After obtaining my BS degree in metallurgy, 1 joined the General Electric Company and I was assigned to various divisions for a period of three months. One of these assignments was at the Corporate Research Laboratory and I undertook the research working with J.R. Low, Jr., a senior member of the staff at the laboratory.

"The mechanical properties of crystals are controlled by the behavior of crystal defects, called dislocations. At the time the research was initiated, it was generally assumed that dislocations were either static or moving near the speed of sound in crystals and the macroscopic behavior of solids was interpreted on this basis. Work by Johnston and Gilman[1] on lithium floride challenged this assumption and we were interested in determining if their findings were applicable to metals.

"There were two major problems to be overcome: the preparation of low dislocation density single crystals of a metal, and the introduction of dislocation of the appropriate type that would move under an axial bending stress. Just after we had solved the first problem, an eminent member of the staff explained to me why our approach was thermodynamically impossible and we solved the second when I made a mistake in a calculation concerning the design of our indentor. By the time I discovered the error, we had made the indentor and it was the only one that worked well. Once these problems were overcome, the experiments were rather simple and the work went forward at a brisk pace, although it did require an extension in my assignment of a second three months to complete the work.

"The paper demonstrated two important properties of dislocation in metals. The first was that the velocity depended upon the applied shear stress and the velocity varied over several orders of magnitude. This demonstrated that the hypothesis that a dislocation was either static or moving near the speed of sound was incorrect. Secondly, the paper demonstrated that the temperature dependence of the yield strength of body centered cubic metals was a consequence of an increase in lattice resistance to free moving dislocations with decreasing temperature. At the time it was thought that the temperature dependence was due to a locking of dislocations by impurity atoms such as carbon or nitrogen. This locking theory was developed by one of the most famous metallurgists of our time, Allan Cottrell, and was widely accepted. Cottrell visited our laboratory while I was doing these experiments and I showed him what we were doing. He immediately accepted that the results overturned his theory and he was one of the leading spokesmen spreading the results of our work. It was a great lesson to see the openness and receptiveness of this great scientist to the results of a neophyte in the field once he was convinced the experiments were correct.

"The paper was probably the primary reason I received the Hardy Gold Medal of the AIME in 1963 as the most promising metallurgist under the age of 35 in the US. This research also convinced me that research was a lot of fun and changed my career plans from management to research for 20 years. About a year ago I regressed to my earlier plan."

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[1] **Johnston W G & Gilman J J.** Dislocation velocities, dislocation densities, and plastic flow in lithium fluoride crystals. *J. Appl. Phys.* **30**:129-44, 1959.