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This Week's Citation Classic

Edelson B I & Baldwin W M, Jr. The effect of second phases on the mechanical properties of alloys. *Trans. ASM* 55:230-50, 1962.

[US Navy, Bureau of Ships, Navy Dept., Washington, DC and Case Inst. Technology, Cleveland, OH]

Mechanical properties of two-phase alloys were measured and related to microstructure. Strength was found to correlate with mean free path between second phase particles, and ductility with volume fraction of second phase particles. Strain concentration was found to be the embrittling mechanism. [The *SCI*® indicates that this paper has been cited in over 110 publications since 1962, making it among the dozen most-cited articles published in this journal.]

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"During the 1950s, as a young naval officer, I was working toward a PhD degree in metallurgy at Yale University. Taking advantage of an assignment in Cleveland, Ohio, I made arrangements to do research work at Case Institute of Technology under the guidance of the late William M. Baldwin, Jr., a noted physical metallurgist, who agreed to act as my thesis adviser *in absentia*.

"Baldwin's approach was straightforward—pick an engineering problem you'd like to illuminate, perform tests, observe behavior, and then try to figure out a theory.

"We decided to explore the behavior of two-phase alloys, an emerging new class of engineering materials. I did the experimental work over a period of three years, theorized, concluded, and wrote it up under Baldwin's guidance. Then I submitted my manuscript, typed and bound in black, to Yale in mid-spring 1959—hoping to get the degree in June. Two days before my scheduled oral defense, I remember well receiving a telegram (in those days they came by messenger) saying in effect, 'Do not bother to come to New Haven, the committee has read your dissertation and found it unsatisfactory!' Of course, I was quite disappointed and not a little discouraged by the fact that the Navy was transferring me to Washington, so I could not do a repair job at Case. Fortunately, I was able to set up shop at the Naval Research Laboratory (NRL) in Anacostia; do a new set of experiments, which fortunately gave added confirmation to my theory; rewrite the dissertation; and submit it to Yale in May 1960. This time it was accepted.

"I then published the results of the work in two parts. The first part, coauthored by Baldwin, covering research done at Case and rejected by Yale, received considerable attention. Several letters to the editor followed publication—some laudatory, others quite critical. In 1963, that paper won the prestigious Henry Marion Howe Research Medal of the American Society for Metals.

"Now, 20 years later, that same paper has been selected as one of the most-cited references. What a vindication! (P.S. The second publication,[1] that covering research done at NRL and accepted by Yale for the degree, won no awards and received few, if any, citations.)

"Why has this paper been so frequently cited? Two reasons I believe: because it was bold, and because it was relevant. The paper, based on limited evidence, set forth new rules and described new mechanisms for physical properties of two-phase materials: ones easily tested and corroborated, or disproved. Fortunately, two-phase alloys became very important engineering materials in the ensuing years. Why was the work rejected for the degree? Because it was controversial—it was perceived as having too definitive conclusions based on too little evidence. Perhaps the Yale committee was right to have made the decision they did in 1959. However, history seems to have proved them wrong, or at least shortsighted. See references 2 and 3 for reports of recent work in the field."

1. **Edelson B I.** Strain concentration and ductility. *Trans. ASM* 56:82-9, 1963.
[The *SCI* indicates that this paper has been cited in 5 publications since 1963.]
2. **Hahn G T & Rosenfield A R.** Metallurgical factors affecting fracture toughness of aluminum alloys. *Met. Trans. A—Phys. Met. Mater. Sc.* 6:653-68, 1975.
3. **Trefilov V I, Pokhodnya I K, Moiseev V F & Vasiliev A D.** Ductile-brittle transition in refractory metal alloys containing a dispersed second phase. *Phys. Status Solidi A—Appl. Res.* 59:843-51, 1980.