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NANO HIGHLIGHT
Minimum Nanocrystalline Grain Size Obtainable During Cryomilling

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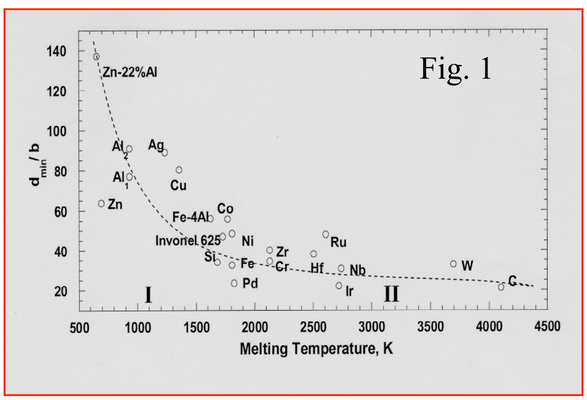
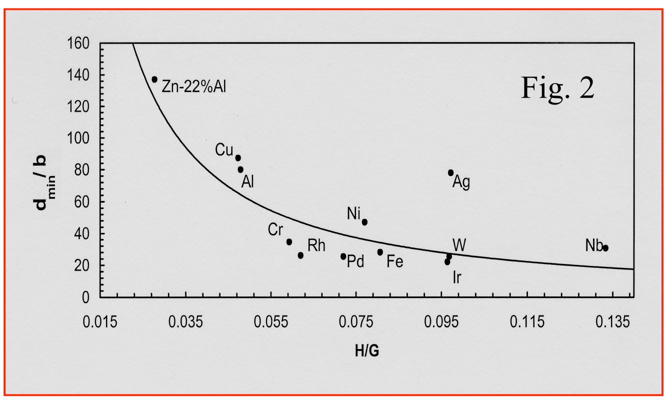
Nanocrystalline materials (nc-materials) are polycrystals that are characterized by a grain size in the range of 1-100 nm. The unique microstructures of nc-materials suggest that these materials have the potential of exhibiting exceptional mechanical properties. As a consequence, they have been attracting wide attention in materials research. Primary among the processing techniques that are available for synthesizing nc-materials is ball milling [1, 2]. The technique of ball milling has advantages in term of simplicity, cost, and bulk production. The characteristics of the grain size obtained during ball milling have been studied extensively over the past several years. It has been shown that continuous milling leads to a minimum grain size which is a characteristic of each metal. The purpose of this study is to examine the possibility of the presence of correlations between the minimum average grain size, d_{min}, and material properties including melting temperature, T_m, and hardness, H. Such correlations, if present, should provide insight into the mechanisms responsible for the production nc-materials by milling.

In Figure 1, average minimum grain size data are plotted as $d_{min}/\mathbf{b}$ versus melting temperature, T_m, where **b** is the Burgers vector. Consideration of Figure 1 reveals that despite the presence of some scatter, data of nc-metals, regardless of their crystal structure, define a single curve. In Figure 2, the data for FCC and BCC metals are plotted as $d_{min}/\mathbf{b}$ versus the normalized hardness, H/G, where G is the shear modulus and H is Vickers hardness of the metal. As indicated in this figure, the decrease in $d_{min}/\mathbf{b}$ with increasing H/G, parallels the decrease in $d_{min}/\mathbf{b}$ with increasing T_m [3]**.** The correlations shown in these figures are consistent with the predictions of a new dislocation model [4] that is based on the concept that the minimum grain size is the result of a balance between hardening and recovery.





References

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