Grain boundary pseudopartial wetting

A.B. Straumal[1]*, A.A. Mazilkin[1,2], B.B. Straumal[1-3], B. Baretzky[2]

[1]Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, Russia
[2]Karlsruher Institut für Technologie, Institut für Nanotechnologie, Eggenstein-Leopoldshafen, Germany
[3]National University of Science and Technology «MISIS», Moscow, Russia
*a.str@bk.ru

Usually one distinguishes partial and complete wetting of surfaces or interfaces. In case of partial wetting contact angle $\theta > 0$ and the liquid droplet is surrounded by "dry" surface or interface. In the majority of cases the direct transition occurs from partial wetting into complete wetting, for example by increasing temperature or decreasing pressure. However, in some cases the state of pseudopartial wetting occurs between partial and complete wetting. In this case the contact angle $\theta > 0$, the liquid droplet does not spread over the substrate, but the thin (few nm) precursor film exists around the droplet and separates substrate and gas. Such precursor film is very similar for the liquid "pancake" in case of complete wetting and deficit of the liquid phase. The pseudopartial wetting has been observed before only for liquid/liquid mixtures (alcanes/water solution of salt or glucose) or Pb and Bi on the Cu surface. We observed the pseudopartial wetting of Al/Al grain boundaries (GBs) by solid Zn in the Al – 10 wt.% Zn ultra-fine grained polycrystals. The solid Zn partially wets Al/Al GBs (with non-zero contact angle). Nevertheless, the Al/Al GBs contain the 2 nm thin uniform Zn-rich layer connected with Zn grains. Such thin layers are the reason of high ductility of ultra-fine grained Al–Zn alloys at room temperature. This phenomenon opens the way for development of novel light-weight alloys. The pseudopartieal GB wetting by a liquid phase exists also in the WC–Co hard alloys. The pseudopartieal GB wetting by various liquid and solid phases also controls the properties of Nd–Fe–B-based hard magnetic alloys.