Some thoughts on Dislocation Nucleation

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The usual way that partial dislocations are taught in textbooks on dislocation theory is to start with a total dislocation with a Burgers vector $b$ that may then be dissociated into two (sometimes more) partials with Burgers vectors $b_l$ and $b_t$ for leading and trailing partials, respectively. However, in this paper we start by assuming that in a crystal subject to a shear stress $\tau$ first the leading partial dislocation is nucleated on the slip plane that starts to glide and because of its non-integer lattice vector generates a stacking fault with an energy per unit area $\gamma$. After a travel time $t$ and a travel distance $d$ on the glide plane the trailing partial dislocation is nucleated. If the core of the partials overlap within the distance $d$, the dislocation is considered to be perfect and its Burgers vector is taken to be $b$. On the other hand, if $d$ is larger than the overlap distance, the dislocation is considered to be dissociated. This discussion leads us into how surface twins may form in a crystal. The influence of different factors, including line tension, image force, lattice (Peierls) resistance and stacking fault energy on nucleation of a partial dislocation are considered and the importance of each assessed. We shall also discuss the nucleation frequency of the two partials, that of the total dislocation, and the distance $d$ which is the stacking fault width. An attempt is made to estimate $t$ and $d$, and thus the stacking fault energy $\gamma$ for a covalently-bonded material.