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Initial Energy Dissipation Mechanism at Crack Tip and the Ductile to Brittle Transition

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It is commonly assumed that the trigger for the brittle to ductile transition of a material is a change in the initial energy dissipation mechanism that is activated near or at a crack tip. In this talk, the criteria which determine the initial energy dissipation mechanism that is activated at or near a crack tip are derived. The possible mechanisms considered are cleavage, crack tip dislocation nucleation and also Frank-Read dislocation source activation near the tip. The applied energy release rates at which cleavage and crack tip dislocation nucleation occur are well-known. An elementary derivation of the applied energy release rate required for Frank-Read dislocation sources to be activated will be presented. Competitions between the three mechanisms are then established in terms of ratios of the respective energy release rates. The criteria can be succinctly expressed in graphical form and compare favorably to experiments in the literature.

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