The role of deformation twins

in a ductile to brittle transition and brittle fracture of ferritic steels

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Key words: ductile to brittle transition, brittle fracture, deformation twins, ferritic steels

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Abstract: The fundamental question which basic factors determine the temperature and shape of the brittle to ductile transition remains unanswered, Hirsh [1]. According to Thomson and Knott [2] the calculations of experimentally-measured values of fracture stresses indicate that inherent nuclei of cleavage microcracks with length of the order of several ìm should be present in ferritic steel. Our experimental results indicate that:

1. in various ferritic materials and under various deformation conditions there is a correlation between the deformation mode (twinning) and the fracture mode (cleavage)
2. in the transition temperature region deformation twinning represents an integral part of deformation processes ahead of the growing crack tip
3. the intersections of active slip systems with unfavorably oriented deformation twin boundaries act as nucleation sites for cleavage fracture nuclei (pre-cleavage microcracks)

Based on experimental results we propose:

1. change of fracture mode of ferritic steels in ductile to brittle transition temperature region is a direct consequence of the change of deformation mechanism from deformation by slip of matrix dislocations to deformation by slip *and* twinning
2. brittle/cleavage fracture is governed by the nucleation of pre-cleavage microcracks (PCMCs) on deformation twins ahead of the growing crack tip, deformation twins thus acting as inherent nuclei of cleavage in ferritic steels

[1] P. B. Hirsch, Mat. Trans. JIM 30 (1989) 841.

[2] A.W.Thompson, J.F.Knott, Metall.Trans.A, 24A (1993) 523.

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The paper is proposed for oral presentation