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3D Imaging of Hydrogen Induced Cracking in Pipeline Steel

Environmental conditions of service affect the resistance of pipeline steels to failure, as a result, the applied stress which would be otherwise considered safe can be responsible for fracture due to hydrogen induced cracking (HIC). In Fig. 1-a hydrogen blister and HIC cracks were clearly visible in 3D imaging. The 3D imaging revealed that HIC cracks formed at the mid-thickness of the sample as well as at other planes of the sample parallel to the rolling direction which means HIC cracks can be formed anywhere in the sample depending on the favorable condition. The imaging also revealed that the HIC cracks that formed on different planes were connecting to each other when tensile stress was applied (Fig. 1-b). This indicated that HIC cracks were also involved in reducing the tensile strength of the steel as the connection of two cracks in two planes parallel to the loading direction made the crack orientation perpendicular to the loading direction and therefore becoming an additional factor contributing to tensile failure. Fig. 1-a also shows the surface blisters that were formed when cracks near the surface could not propagate further inside steel specimens.

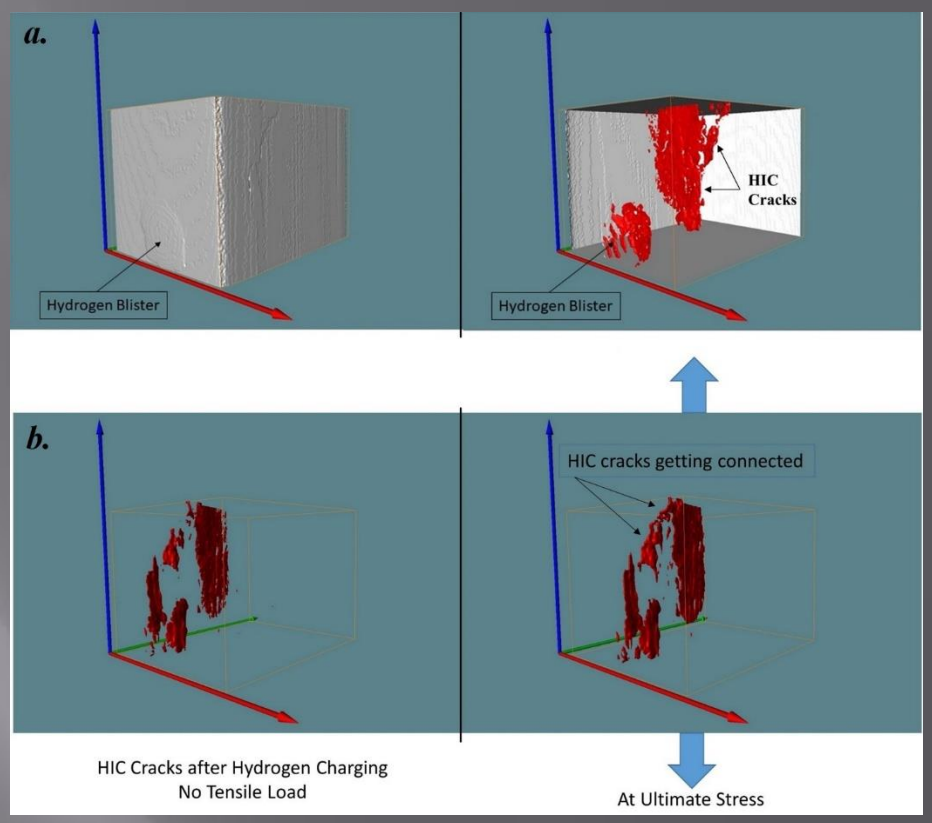

Figure 1. 3D Imaging of Hydrogen Induced Cracking.

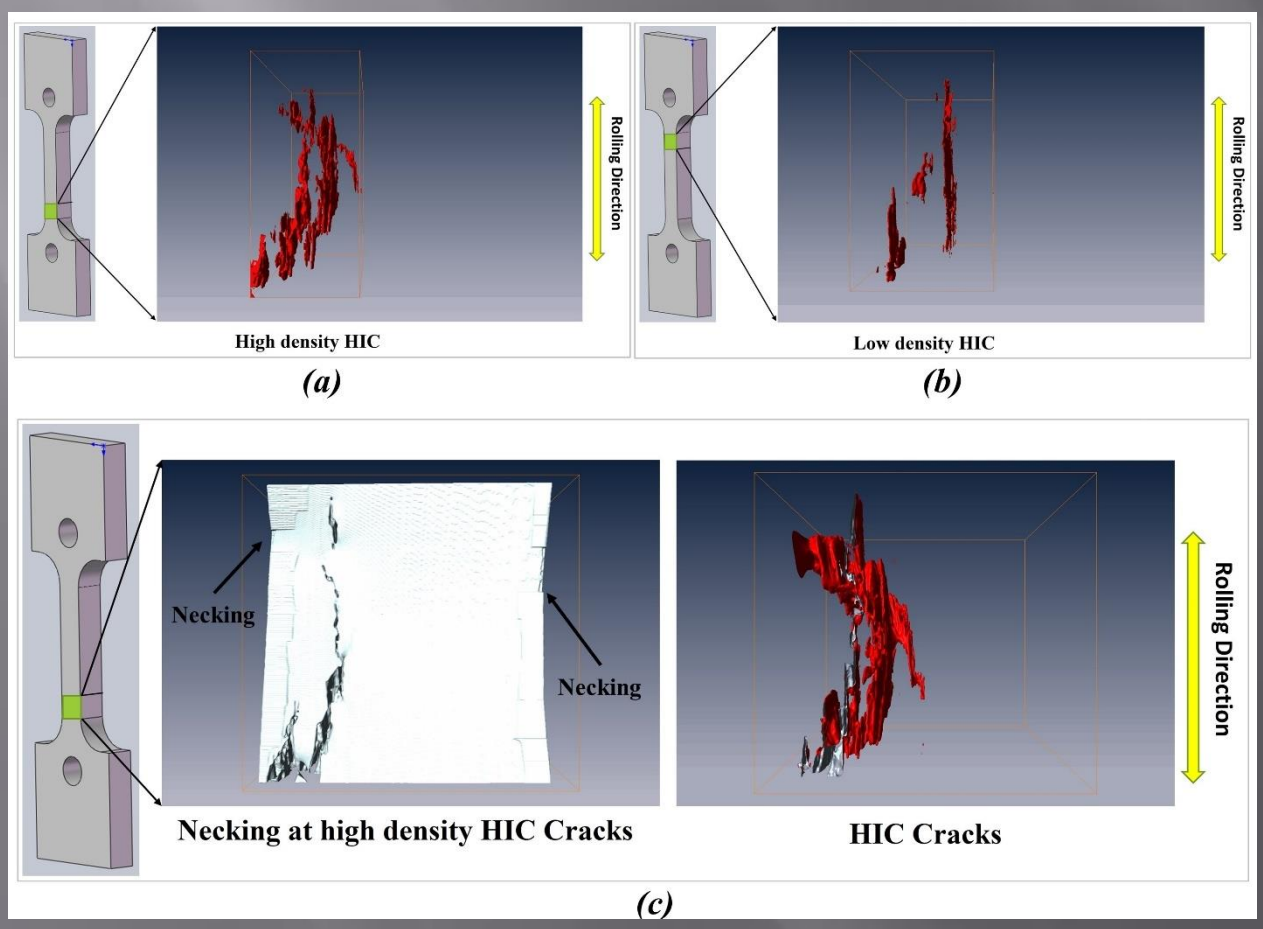

Figure 2. 3D Imaging of Tensile Failure Dependency on HIC Morphology.

Fig. 2 explains the dependency of hydrogen induced cracking morphology in tensile failure. Fig. 2-a and Fig. 2-b are two different position of the tensile sample which have different morphological HIC cracks in those regions. 3D imaging in Fig. 2-c revealed that the necking region had the high density of HIC cracks which act as stress raisers and get connected during failure and reduces the strength of the steel.