Investigation of phase transformations in heat resistant steels and their consequences on microstructural evolution and mechanical properties

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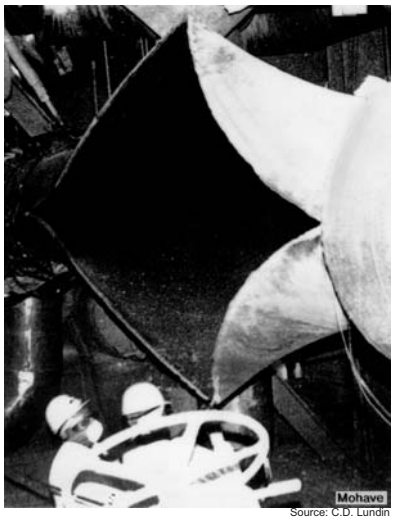
Heat resistant 9% Chromium steels are favoured steel grades for the construction of thermal power plants. Fusion welding is the major joining and repair technology for such power plant components. The weld thermal cycle results in phase transformations during the welding process in a narrow region parallel to the weld fusion line.



Source: C.D. Lundin

Figure 1: Catastrophic failure of the main steam pipeline along the longitudinal weldment in a US thermal power station.

These phase transformations alter the microstructure of the steel in a negative way and lead to a reduced lifetime of welded structures.

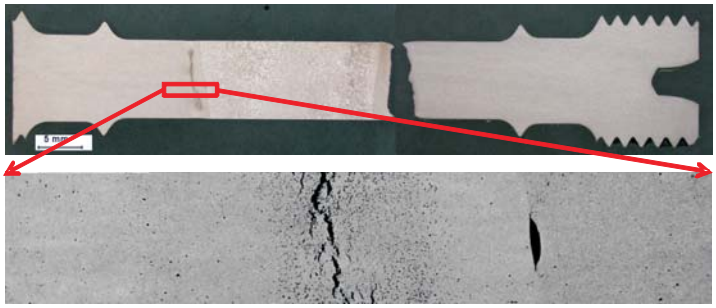
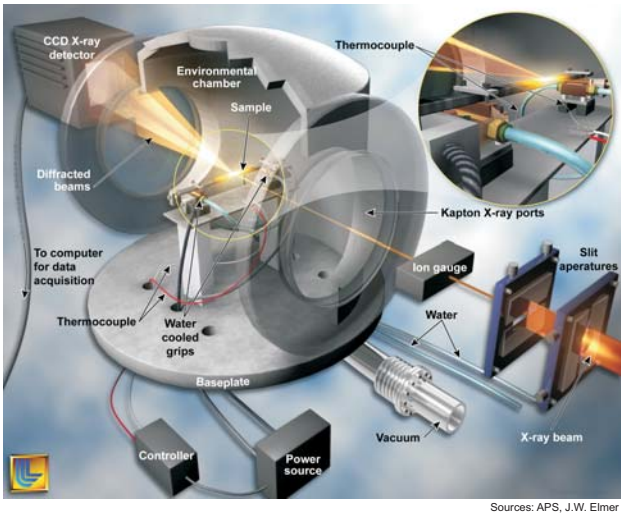


Figure 2: Fractured crossweld specimen with weld region in the centre of the specimen (top) and micrograph of the very localised damage by creep void formation parallel to the weld fusion line (bottom).

In the following program, the influence of the weld thermal cycle on the microstructure and the mechanical properties of heat resistant steels will be investigated.

Phase transformations during welding can be monitored in real-time by in-situ X-ray diffraction using synchrotron radiation. X-ray diffraction experiments will be carried out at the Advanced Photon Source of Argonne National Laboratory.



Sources: APS, J.W. Elmer

Figure 3: Synchrotron Facility, Advanced Photon Source APS of Argonne National Laboratory (left) and schematic of X-ray diffraction experimental setup (right).

Diffraction experiments will be supported by most advanced electronmicroscopic methods and mechanical testing. This program should allow new insights in phase transformations during welding and result in an improvement of 9% Chromium steels.