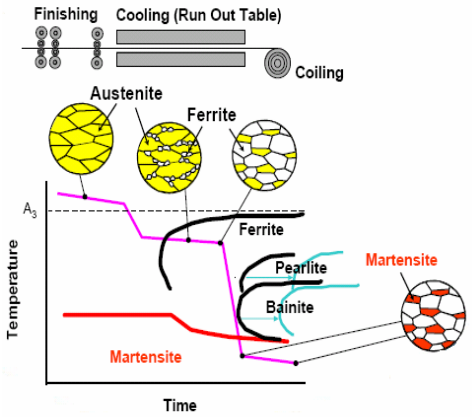
Huys Technical Library #25

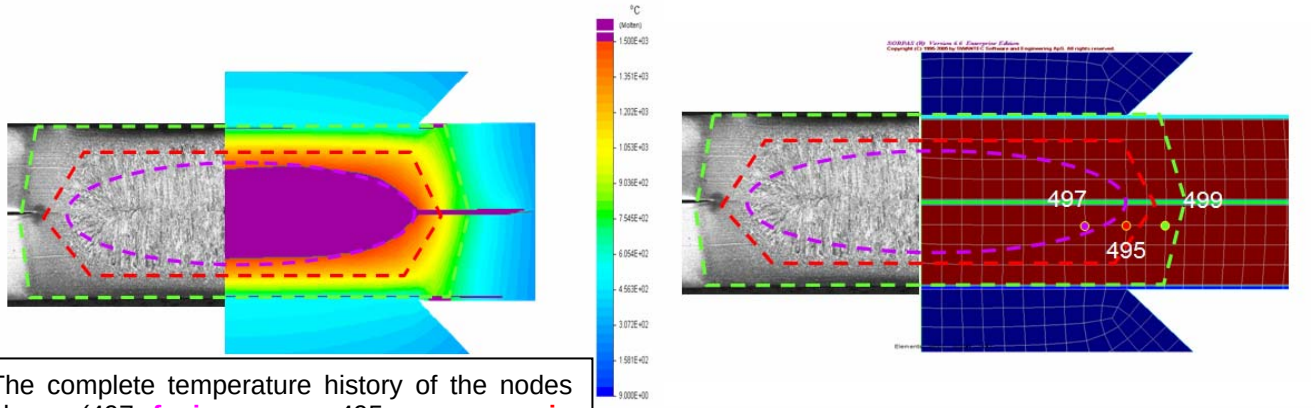
PREDICTING MICROSTRUCTURE

Ibraheem Khan of the University of Waterloo has shown how SORPAS® resistance welding simulation software can predict the microstructure of welds. The microstructure of a weld directly influences its strength and ductility. Thus, performance characteristics of resistance welded joints can be designed and planned *prior* to the actual welding.

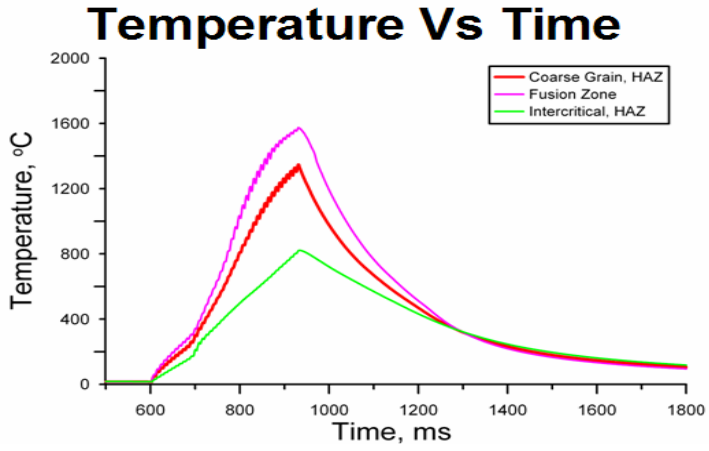


(Jeff Gao "Metallurgy of Dual Phase Steels")

Steel manufacturers are able to make the next generation of steels by carefully controlling the temperature as it cools. Steels made at different temperatures have differing strengths and characteristics. At left, we see a chart indicating how dual phase steel is created at a defined cooling rate. Different materials form at different time/temperatures. The same process occurs when parts are welded, and the characteristics of welded joints can be significantly different than the parent material. SORPAS® software predicts the weld; from the fusion zone, through the heat affected zone (HAZ) to the virgin parent material. Below, actual micrograph photographs are combined with the SORPAS® outputs. The output indicates temperatures obtained in the weld (left) and individual points (nodes) in the FEA mesh are indicated as 497, **fusion zone**, 495 **coarse grain HAZ**, and 499, **inter-critical HAZ** (right).



The complete temperature history of the nodes above (497 **fusion zone**, 495 **coarse grain HAZ**, and 499 **inter-critical HAZ**) are plotted at right by the software. Plotted against time, the peak temperatures and cooling rates can be determined and compared to published constant cooling diagrams to help determine the final microstructure and characteristics of the weld. (Turn the page over to see how this has been done). Knowing the ***characteristics*** of the weld helps in the correct set-up of the welding parameters to optimize the weld strength and hardness, preventing failures and saving time and money – and helping to reduce inspection, testing and scrap from poor parts and prototypes.



Huys Industries gratefully acknowledges the financial assistance and technical insights of:

National Research Council Canada
Conseil national de recherches Canada
University of Waterloo
Queen's University
Materials and Manufacturing Ontario

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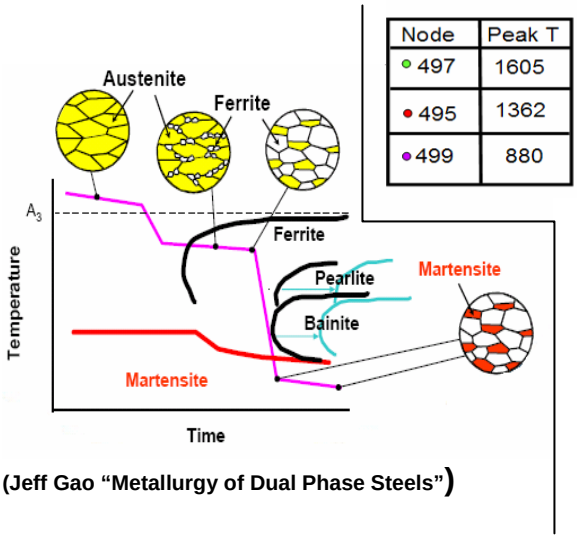
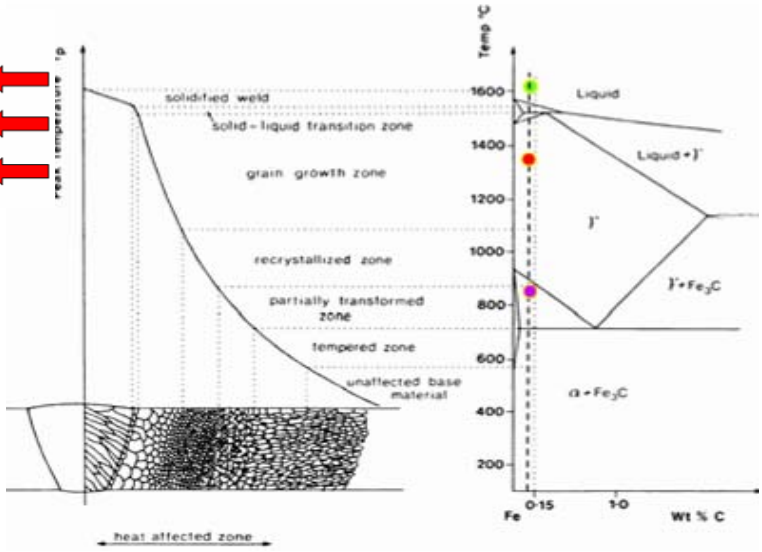
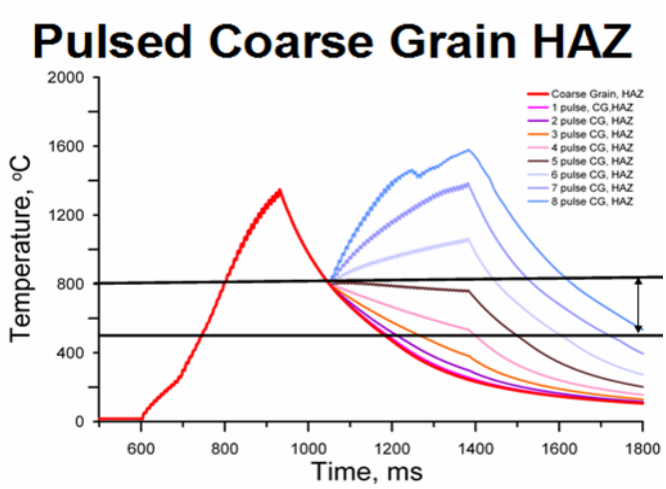
PREDICTING COOLING RATES

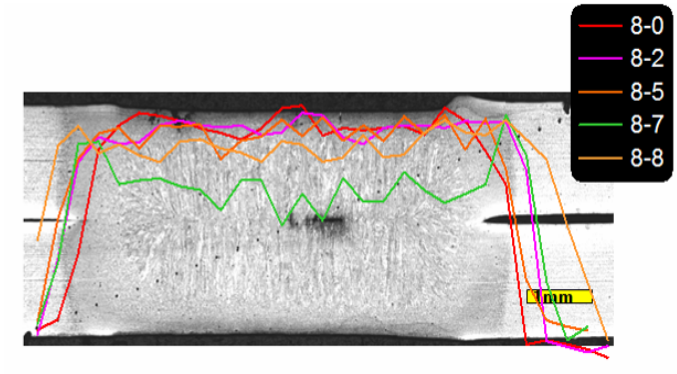


Node	Peak T
497	1605
495	1362
499	880

(Jeff Gao "Metallurgy of Dual Phase Steels")







The peak temperatures of the nodes from the SORPAS® weld on the previous page are indicated with coloured dots on the steel phase diagram above. The location and peak temperatures of the nodes coincide with the predicted microstructure. This indicates the microstructure of the simulation is comparable to published graphs and to the actual samples micrographed. Thus SORPAS®'s predictive power is confirmed.

To the left, a second weld pulse was added to the simulated weld schedule to control the cooling rate of the weld. Sorpas® was able to simulate many different second-pulse currents and display the cooling rates in the Coarse Grain HAZ for each. Comparing the predicted cooling rates given by Sorpas® to the Cooling Diagram in the upper left, the second weld pulse can be selected to best reproduce the original cooling and microstructure and reduce the formation of martensite. The bottom left shows actual reduction in final weld hardness using the simulated parameters (8-7). Weld character was changed on the first weld tested, using Sorpas® to eliminate many trials.

Thus SORPAS® allows the user to adjust the heat input into the weld, predict the weld, and assist in determining the desired microstructure in the final product. With the increased adoption of new, advanced high strength steels (AHSS), such power and analysis will be appreciated by customers trying to minimize costs while maintaining quality.

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