American Iron and Steel Institute

Q & A

AISI NEW GENERATION OF PRESS HARDENED STEELS WEBINAR
1.7-2.0 GpA PHS WITH ENHANCED BENDABILITY

Question responses by Jeff Wang, Site Leader, General Motors China Science Lab and Manager, Structural Metallic Systems Research

Q: Is there any difference between the hot stamping procedures for the new PHS compared to the old AlSi coated? Is there a specific schedule to achieve this microstructure?

A: There is no difference between the hot stamping procedure/schedule (austenitization temperature/time) for the coating free PHS and AlSi-coated PHS.

Q: How did you reveal the PAG boundaries?

A: We used picric acid plus surfacant, a detailed procedure can be found in: "Effect of Prior Austenite Grain Size on Impact Toughness of Press Hardened Steel" by J. Wang, C. Enloe, J. Singh and C. Horvath, SAE International Journal of Materials and Manufacturing, Vol. 125, No.5 (2016).

Q: Does the new steel have any additional corrosion protection?

A: It may have some degree of corrosion protection, due to the passivated surface (dense chrome oxide of sub-micron thickness).

Q: For the oxidation-free PHS, has there been any effort to characterize the coefficient of friction (vs. temp and pressure)?

A: This has yet to be pursued.

Q: What are the substrate mechanical properties (before heat treatment in PHS) of the 20MnCr material?

A: The substrate mechanical properties for cold rolled and annealed 20MnCr are similar to that of the as-received AlSi-22MnB5: about 400Mpa yield strength, 600-650MPa tensile strength and 20-25% tensile elongation.

Q: What is the substrate mechanical properties of the other variants 34MnBV, facilitating processing into blanks for the PHS process?

A: The substrate mechanical properties of the other variants 34MnBV are as-received 34MnBV: yield strength 450-500MPa, UTS 750-800MPa, Total elongation of 18-20%.

Q: In 2GPa PHS, is the V benefit really due to VC formation rather than a solid solution effect?

A: The formation of VC plays an important role in making the martensite less brittle and at the same time, nano-sized VC precipitate contributes to strength. There may be some V in the solution form, which we have not yet verified.

Q: How do you model the weld zone in TWB sheet?

A: This has yet to be pursued.

Q: In coated steel, what would be the inter diffusion layer thickness in microns?

A: This would depend on the austenitization temperature and time. For the AlSi-coated PHS discussed in this webinar, the inter diffusion layer is about 7-8 microns.

Q: What is the production cost of the new PHS as compared to 22MnB5? Have you tried Zinc coating on the new PHS?

A: The cost of producing the new PHS (without coating) is slightly higher than the bare 22MnB5 due to richer alloying elements and some adjustment on steel making process. But it should be on-par with the AlSi-coated 22MnB5, because the cost of AlSi-coating might be able offset the extra cost in producing the steel substrate. We have yet to try Zinc coating on the new PHS grades.

Q: It appears on the cross-sections that the new bare PHS has a thinner surface F layer than the new PHS with slim coating. Was the difference caused by a) CGL vs. CAL (faster), or b) the effect of Al on the formation of F?

A: If F refers to ferrite, we do not have ferrite in the microstructure after hot forming.

Q: What trimming technologies do you propose for these new materials? Laser only or also hard-trimming or in-die cutting?

A: Laser only after hot forming.

Q: Cross hatch and chipping tests are not particularly rigorous nor representative of the expected applications. Are there any lap shear results with high-modulus adhesives?

A: The adhesion test has not yet been evaluated, but it is planned.

Q: How will the coating-free version fare vs. the aluminized version when exposed to a corrosive environment?

A: After a typical production Elpo process, it is expected that the coating free PHS will have similar corrosion performance as the AlSi-PHS.

Q: Is the new alloy strategy simply adding hydrogen traps?

A: This question is likely more applicable for the 2GPa Slim AlSi-coated PHS. Adding a hydrogen trap is one of the alloying strategies. Other important strategies include reducing carbon in martensite by VC precipitation, grain refinement and elimination of TiN.

Q: Is the delayed fracture test electrolyte aerated? Oxygen reduction can complicate matters for hydrogen mobility, reduction, and adsorption.

A: There is no air injection into the electrolyte during the acid immersion test. The oxygen reduction might complicate the test. However, the goal is for an A-to-B comparison for the Slim AlSi PHS vs. the regular weight AlSi PHS.

Q: Regarding the 20MnCr material, you mentioned Cr+Si+Mo<=4.0wt%. I am wondering about the range of wt% for [Cr] content. What is the typical value? Have you done cyclic corrosion test with 20MnCr material?

A: While we are not able to disclose the Cr%, currently, the cyclic corrosion test is ongoing.

Q: In my experience, 2.0GPA PHS, over 0.3% carbon in chemical composition could not weld with a stack up condition. Do you have further research?

A: It is a challenge when welding 0.3% carbon steel to itself. However, it is okay when welding to a dissimilar steel with less carbon content, for example, DP600.

Q: Does PHS prevent damage transfer into a vehicle? Is there an expectation that cars will be more repairable?

A: The goal of using 1.7GPa and 2.0GPa is to have better anti-intrusion. We do not know the impact on repairability yet.

Q: Have any solid-state joining trials been done on the new PHS, such as Friction Element Welding?

A: Not at this time.

Q: Who has the Intellectual Property for 20MnCr? Will other OEMs (other than GM) be restricted from usage?

A: GM has IP on the coating-free PHS, which will be licensed to steel companies for use across the industry, with a royalty bearing fee for non-GM applications.

Q: Are there any studies on laser welding of 20MnCr and 34MnBV steels, such as Laser Welded Blanks?

A: No laser welding done for 20MnCr at this time. Laser welding of the Slim AlSi-coated 34MnBV does not require laser ablation to partially remove the AlSi-coating.

Q: Do you see any decarburization on the high Cr steel? If yes, what thickness of decarburized layer is acceptable?

A: Decarburization can happen if the process is not controlled well - either in steel production or during hot stamping. Currently, we don't have an established criterion on the acceptable depth of decarb.

Q: At what point in the press hardening process does the ultra-thin oxide layer form in the 1.7GPa coating free PHS?

A: An ultra-thin oxide layer forms both in the furnace and in the ambient air during blank transfer from furnace to press.

Q: How does the 1.7 GPa material perform at higher strain rates?

A: Data is not available at this time.

Q: During the talk it was mentioned that Cr alloy has substantially better hardenability. Does this make tailored tempering very difficult?

A: Yes, it appears so.

Q: Will the thin oxide be abrasive? Will surface coefficient of friction change? Will soak process windows change?

A: Data is not available at this time for the first two questions, but the soak process stays the same.

Q: Have you replaced B and Ti that are cheaper with more expensive Cr, Mo, and Nb. How much has this increased the cost of the raw material?

A: Due to anti-trust guidelines, we can't comment on pricing.

Q: Are you able to comment on Delayed Fracture samples cut-edges (i.e. laser-cut or shear, or something else)?

A: EDM was used to cut the samples.

Q: Can you comment on diffusible H pick up differences between developed steels compared to other PHS steels?

A: Diffusible H pick up differences compared to developed steels has not yet been evaluated but has been added to the plan. However, it is expected that the coating-free 20MnCr will have much less H pick up in the furnace, because it does not have AlSi-coating.

Q: Has there been an assessment of the hardenability values for these new grades, and how do they compare to the standard 22MnB5 grade?

A: The 1.7GPa steel has a critical cooling rate of about 10C/s (essentially air hardened for thicknesses less than 2.0mm). The 2.0GPa steel has a critical cooling rate of about 20-25C/s.

Q: What's the price comparison (percentage) between Coating-free 20MnCr and 22MnB5? Now and predicted in the future (maybe in 5 years)?

A: Due to anti-trust guidelines, we can't comment on pricing.

Q: Is a protective gas atmosphere required for 20MnCr in the heating furnace?

A: Yes, it is dry nitrogen.

Q: Could you specify the mills in America or Asia where we could get more information on these four materials?

A: Due to anti-trust guidelines, we can't disclose the names of the mills at this time.

Q: Any comments regarding the thickness availability for the four materials?

A: The thickness should cover the range for an automotive application - typically 1.0 to 2.5mm.

Q: What is the difference in the yield stress between these grades?

A: The 1.7GPa has a yield strength of 1300MPa after paint baking, while the 2.0GPa grade has about 1500MPa yield strength after baking.

Q: What is the maximum thickness for 2GPa Sheet metal?

A: That will be depend on the customer's request and mill capability - 2.5mm should be possible.

Q: Do you think there is a new lower practical gage limit for this material? What would that lower limiting gage be?

A: The lower gage limit is likely to be set by hot stamping process, for example, 0.8-0.9mm PHS may have blank handling issues. A 1.0mm is a better practical lowest gage for these two steels.

Q: Given the high alloy content, has the grade been evaluated for cyclic corrosion, such as SAEJ2334, salt spray chamber, or in the application field?

A: Currently the cyclic corrosion test is ongoing.

Q: Is the HAZ (welding) the same diameter as the AlSi-coated material or is it an increased size?

A: It is the same diameter HAZ.

Q: For the bumper, was the same thickness used as before?

A: Yes, the same thickness was used.