Huangshi Alta Special Steel Co.,Ltd
No. 86 Road Hexi, Xisaishan Industrial Park, Huangshi city, Hubei Province, China
Tel: 86 714 3064045 Fax:86 714 3046045 Contact: sales@altaspecialsteel.com Website: www.altaspecialsteel.com

Technical Study on surface Quality and Non -uniformity of Eutectic Carbides of Cr12MoV Steel Forging

Abstract: By means of controlling chemical compositions, adjusting pouring process, appropriately decreasing forging temperature, controlling forging rates and forging reduction and adopting light -weight -light forging method, Cr12MoV forging surface quality has been improved and non-uniformity of eutectic carbide can be met the technical requirements.

Cr12MoV is a kind of lattice steel with high carbon and chromium, it's easy to crack during the forging process, also easy to produce a large number of network eutectic carbide during the crystallization process. Cr12MoV steel come with low melting point, poor thermal conductivity, narrow forging temperature range, bad surface quality in the process of forging, hard to meet a high requirements of the non-uniformity of eutectic carbide. Following let us study it.

1. Main technical requires and production process

1. 1 The main technical requires of Cr12MoV steel forging
See the table for the chemical composition of Cr12MoV steel, require the non-uniformity of eutectic carbide ≤ 3.5 class, delivery condition : annealed.

Table 1 - The chemical composition of Cr12MoV steel

C	Si	Mn	Cr	Mo	V	P	S
1.45 - 1.70	≤ 0.40	≤ 0.40	11.0 - 12.50	0.40 - 0.60	0.15 - 0.30	≤ 0.030	≤ 0.030

1. 2 Production process
EAF(melting) → Refining + Vacuum degassing → heating (ingots annealing) → forging → annealing

2. Inspection on the surface quality and non-uniformity of eutectic carbide after forging

Totally there are 23pcs ingots, and all have different degrees of surface cracks. About 50%, the non-uniformity of eutectic carbide is 4.0 class, didn't meet client's requirements, see the table 2.

Table 2 - The surface quality after forging and non-uniformity of eutectic carbide

Heat No.	Size (mm)	Rate of surface cracks	Qualification rate of surface quality	Qualification rate of non-uniformity of eutectic carbide
7035 - 1 - 23	ø 180 - 210	82%	83%	47.80%

3. Analysis and discussion

For one piece of ingots with deep cracks, slice at the crack place and take into physical and chemical

analysis. From the results of the metallographic examination, there is a significant oxidation phenomenon in the grain boundary, and combine with locally over-buring phenomenon on the steel surface. Due to the existence of overheating and over-buring on the surface, cracks are founded during the forging process. Under the microscope, the transverse cracks are observed at the boundary between the over burnt structure and normal structure. The form of longitudinal cracks is cracked along with the direction of forging deformation, and no over-buring phenomenon around the cracks, the structure on the both side of cracks are the same, but the distribution of eutectic carbide on the inside place is very uneven, be judged at 5 to 6 class accord to the GB/T 14979:1994 standard, didn't meet the requirements (≤ 3.4 class). Metallographic picture see the Figure 1 to 8.

Figure 1 - Surface cracks of forging

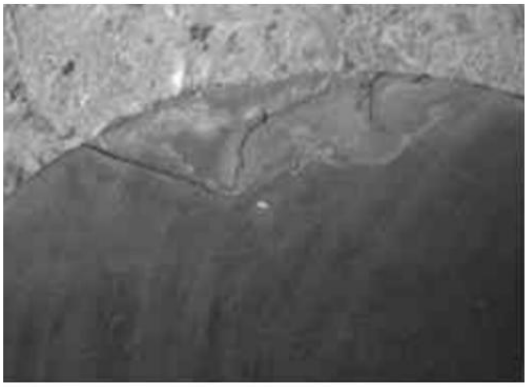

Figure 2 - Crack appearance of macroscopic test piece

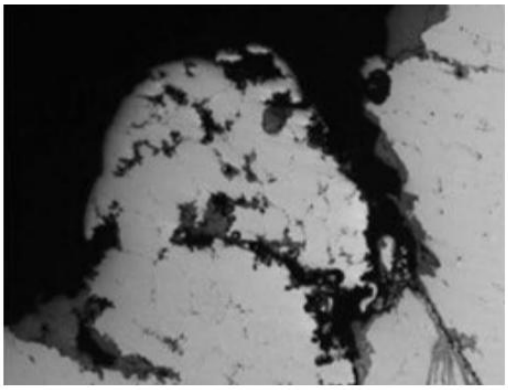

Figure 3 - The oxidation crack on grain boundary extended along the grain (50 X)

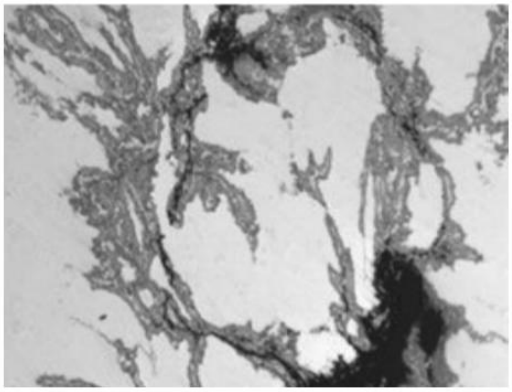

Figure 4 - Intergranular oxidation (50 X)

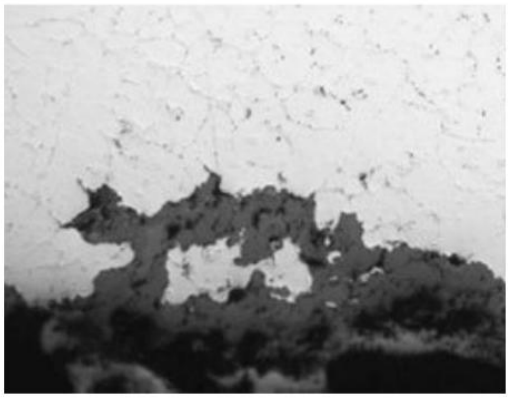

Figure 5 - Network carbide at polished state (50 X)

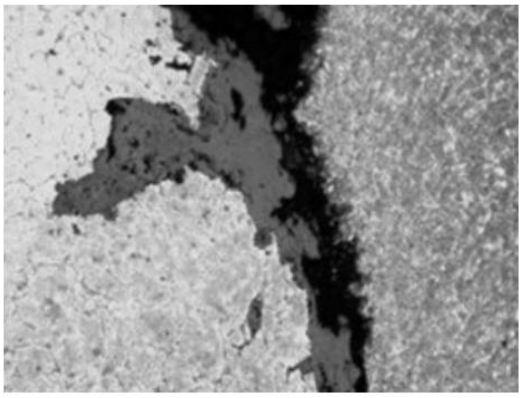

Figure 6 - The different structures on both sides of crack (50 X)

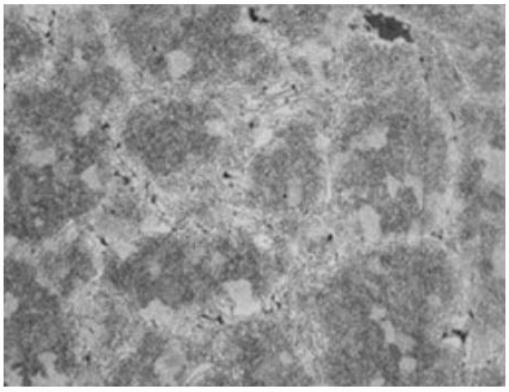

Figure 7 - Eutectic ledeburite on grain boundary (200 X)

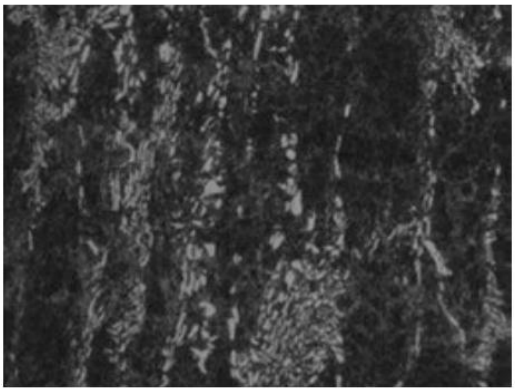

Figure 8 - Non-uniformity of eutectic carbide (100 X)

Accord to the inspection results, the following conclusions can be drawn : due to the high heating temperature of forging, there are over - burning and over - heating phenomenon. Besides, there are a large number of as-cast network eutectic carbides were not be broken according to the inspection results of non-uniformity of eutectic carbide.

Accord to the physical and chemical analysis results, and combine with actual production process, we think that the main reason of deep surface cracks and high level of non-uniformity of eutectic carbide is as the following :

1) Large amount of alloy addition during the smelting process, low composition uniformity, high pouring temperature.

2) The heating temperature is a little bit high for forging, thus produced locally over -burning phenomenon. Additionally, improper forging process lead to a large number of as-cast network eutectic carbides were not be broken.

4. Improvement measure

4.1 Optimize the smelting process

Set internal chemical composition (see table 3), down the content of eutectic carbide formation elements C, Cr appropriately, single amount of alloy addition in the refining process ≤ 1.5 t, adding time interval ≥ 15 min,

to ensure the alloy melting uniformly, soft stirring time before tapping ≥ 15 min. Down the pouring temperature appropriately, the pouring speed is accord to " fast for ingot body, slow for riser" rule. Cleaning the inner wall of ingot mold, and the casting powder need to be dried in dry room.

4.2 Optimize forging process

Sending the ingots to the forging plant after release from mold, pre-heated at 750 - 850 ℃, and the heating temperature is controlled between 1100 to 1150 ℃, The initial forging temperature is adjusted to 1100 - 1000 ℃ and the final forging temperature is ≥ 900 ℃. In order to reduce the quantity of heat during the forging process, it need to control the forging speed and the amount of pressure strictly, to use a forging way "light - heavy - light".

Table 3 - The controlled chemical composition of Cr12MoV steel

C	Si	Mn	Cr	Mo	V	P	S
1.45 - 1.55	0.20 - 0.35	0.25 - 0.40	11.0 - 11.5	0.40 - 0.50	0.18 - 0.30	≤ 0.025	≤ 0.010

Table 4 - The surface quality and non-uniformity eutectic carbide after improved process

Heat No.	Size (mm)	Rate of surface cracks	Qualification rate of surface quality	Qualification rate of non-uniformity of eutectic carbide
0717 - 1 - 15	Ø 150 - 275	20%	93%	87%

6. Conclusion

It has been found that through the control of chemical composition (make the content of C, Cr at a lower level), down the pouring temperature, the pouring speed is accord to " fast for ingot body, slow for riser" rule, and also low the forging heating temperature and final forging temperature appropriately, control the forging speed and the amount of pressure. The surface quality and non-uniformity of eutectic carbide can get substantial improvement.

ALTA is good at manufacturing and supplying Cr12MoV steel, which cover rolled and forged bars, with the following size range.
Diameter : 8mm to 450mm (0.3” to 17.7”)
Thickness : 2mm to 350mm (0.0787” to 13.77”), width max up to 860mm (33.86”)

Any requires on the steel materials, please contact ALTA, we are professional and timely deal your issues.
E-mail : sales@altaspecialsteel.com