

试验研究

低碳高硫易切削钢冷加工开裂分析

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摘要:通过金相显微镜和扫描电镜分析,发现低碳高硫易切削钢开裂的原因为钢材近表面的大颗粒夹杂物。大颗粒夹杂物中含有Zr、Na、Mg等元素,是冶炼过程水口和耐火材料的严重侵蚀及保护渣卷渣造成的。

关键词:低碳高硫易切削钢;开裂;大颗粒夹杂物

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1 前言

低碳易切削钢主要用于制作受力较小而对尺寸和光洁度要求严格的家用电器、仪器、仪表、汽车、机床等行业标准件^[1]。低碳高硫易切削钢是一种生产难度较高的钢种,在冶炼过程中易发生卷渣现象^[2],在钢材中形成大颗粒夹杂,导致在使用加工过程中易发生开裂。青钢针对客户寄回的质量异议试样,通过高倍显微镜和扫描电镜进行分析,得出大颗粒夹杂物是引起低碳易切削钢盘条冷拉拔为等边六角棒开裂的主要原因。

2 开裂情况及原因分析

2.1 试样裂纹描述

客户将直径为10 mm规格的低碳易切削钢盘条不经过热处理一次冷拉成型,拉拔至边长为8.0 mm等边六角棒时发现开裂。裂纹沿纵向连续分布,最长为1.54 m,在整件盘条中断续出现。将客户寄回的六角棒试样进行检验分析,查找裂纹产生的原因。

2.2 显微组织分析

试样横截面高倍显示:裂纹长560 μm且裂纹

周围及试样近表面存在大量大颗粒夹杂物,见图1;横截面最长夹杂物长70 μm,纵向长度因无法定位切割未测量;裂纹处金相组织为F+P,为正常组织形态,见图2。对试样进行常规项目检验,分析结果显示:钢材的组织为F+P,晶粒度为7.5~8.0级,心部纵向夹杂物评级为A>3级、D 0.5级,均符合要求。而图1所示分布在钢材近表面的大颗粒夹杂物属于异常现象,在盘条的常规生产检测过程中,钢材的横截面不应出现大颗粒夹杂物。

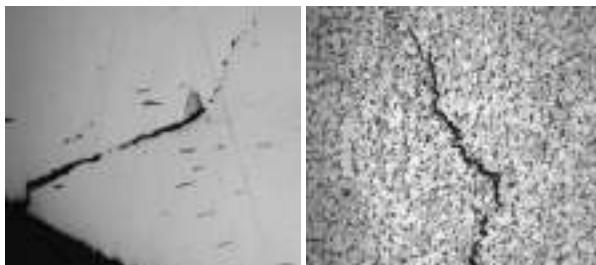


图1 近表面夹杂物 50×

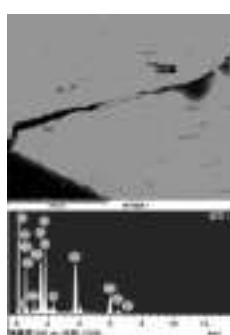
2.3 扫描电镜检测

对试样横向裂纹处、裂纹附近以及近表面的大颗粒夹杂物进行电镜扫描及能谱分析,检测结果见图3(其中w为质量分数,%;x为原子分数,%)。

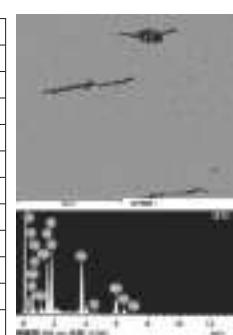


a 裂纹处

元素	w/%	x/%
C K	18.65	33.23
O K	29.28	39.18
Na K	2.05	1.91
Al K	5.72	4.54
Si K	6.37	4.85
S K	3.28	2.19
Ca K	6.43	3.43
Mn K	9.23	3.60
Fe K	17.61	6.75
Zr L	1.38	0.32



b 裂纹附近夹杂物



c 近表面夹杂物

图3 试样扫描电镜及能谱分析结果(横向)

电镜扫描结果显示,横向裂纹处、裂纹附近以

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及近表面夹杂物的元素较多。还存在外来异常元素,如Zr、Na、Mg等,这些元素成分与冶炼环节中的水口、保护渣和耐火材料等有关^[3],说明冶炼及浇铸过程存在水口和耐火材料侵蚀及保护渣卷渣等异

常现象。

2.4 开裂原因分析

通过对试样进行高倍显微镜分析和扫描电镜分析得知,引起开裂的原因为钢材近表面存在大量大颗粒夹杂物。大颗粒夹杂物主要是在冶炼过程中,现场操作人员对水口、保护渣和耐材的在线检测不及时,发生侵蚀现象时没能及时发现,使被侵蚀掉的杂质带入钢液中而形成。

在冷拉拔过程中大颗粒夹杂物难以变形,在基体变形的同时,大颗粒夹杂物受到周围基体的挤压,在拉拔方向承受拉应力断裂形成微裂纹;同时由于大颗粒夹杂物与钢材基体的塑性不同,在变形过程中,大颗粒夹杂物与钢基体之间也会形成微裂纹^[4]。随着拉拔的进行,应力沿微裂纹得到释放产生裂缝^[4];因大颗粒夹杂物沿纵向断续分布且处于近表面,所以在拉拔过程中,裂纹会随着拉拔的进行持续扩展、放大,于是就产生了沿材料拉拔方向的长裂纹,造成材料报废。

3 结语

钢材近表面的大颗粒夹杂物在拉拔过程中容易导致材料发生开裂,而大颗粒夹杂是由冶炼过程中卷渣造成的。低碳高硫易切削钢在冶炼及浇铸过程中极易出现卷渣现象,使盘条内部存在大颗粒夹杂物,所以在冶炼及浇铸过程中应采取防范措施,并加强对成品盘条中横向大颗粒夹杂物的检测,保证出库盘条的质量。

参考文献:

- [1] 周平,刘景华,衣中文.国内外易切削钢综述[J].莱钢科技,2004(6):63-64,90.
- [2] 殷瑞钰.钢的质量现代进展(特殊钢)[M].北京:冶金工业出版社,1995.
- [3] 合金钢钢种手册编写组.合金钢钢种手册(第二册)[M].北京:冶金工业出版社,1983.
- [4] 董履仁.钢中大型非金属夹杂物[M].北京:冶金工业出版社,1991.

Cold Cracking Analysis of Low Carbon High Sulfur Free-cutting Steel

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Abstract: By means of metallographic microscope and scanning electron microscope analysis, found that cracking of low-carbon high sulfur free cutting steel is caused by the large particle inclusions near the surface of steel. The large size inclusions contain Zr, Na, Mg and other elements, which is caused by severe erosion of outlet and refractory in smelting process and the entrapment of mold flux.

Key words: low carbon high sulfur free-cutting steel; cracking; large size inclusion

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Evaluation of Uncertainty in Measurement on Plastic Strain Ratio(r Value) of Metallic Sheet

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Abstract: In order to evaluate the uncertainty in measurement on plastic strain ratio(r value) of deep drawing steel, making St14 steel of thickness 80 mm as an example, the mathematic model of calculating uncertainty of the r value was established and the factors affecting the r value were determined, which include the uncertainties led into by 4 inputs, that is, original width of simple, the forming in width direction, the original gauge length and its distortion, and taken by rounding off numerical values. The standard uncertainty of each factor was calculated. The expanded uncertainty of the r value is 0.08, and the ultimate expression of measuring result of St14 simple r value is $r=1.84 \pm 0.08$.

Key words: plastic strain ratio(r value); uncertainty in measurement; evaluation; expanded uncertainty

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Analysis of Orange Peel Defects in Cold Rolled Sheet

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Abstract: Because orange peel defects appeared in the surface of St13 cold-rolled sheet after deep punching, seriously affecting the use performance, the process parameters and the samples from the sheet with defects were analyzed. The results showed that the chemical composition met the requirement and the annealing parameters were regular, but mixed grain phenomenon in the microstructure of the sample and a small yield point jog existed in the tension test of the sample. The fluctuation of hot rolling process and small rolling force in leveling process are main reasons caused the orange peel defects. Through strengthening process control in hot rolling and optimizing leveling parameter, the yield point jog and orange peel defect were eliminated.

Key words: St13; cold-rolled sheet; deep punching; orange peel defect; yield point jog