

가
J-R
 (Effects of solidified microstructures on J-R fracture resistances of the surge line pipe welds)

150

Cr		AISI	Type 347	GTAW	J-R
	가				.
	,				
가			-ferrite	J-R	
lacy	acicular		vermicular	-ferrite가	
			-ferrite	가	
				Type 347	J-R

Abstract

The cause of the difference in J-R fracture resistances of AISI Type 347 GTAW welds which had almost same amounts of chromium carbides were investigated by the microstructural observations. As a result, the difference in the fracture resistances with the morphologies of the retained -ferrites in Type 347 welds were observed. The fracture resistance of the weld which had mostly vermicular type -ferrites was inferior to the weld which has lacy and acicular mixed type -ferrites. Therefore, it was deduced that the morphology of -ferrites affected the J-R fracture resistances of Type 347 welds.

1.

가

[1]. LBB (leak-before-break,)
 , Type 347 가
 J-R 가
 가
 Type 347 -
 ferrite Cr [2, 3].
 -ferrite Type 347
 가 [4 - 6].
 J-R 가 [7].
 -ferrite J-R

2.

(1) 가 GTAW (gas tungsten arc welding) heat Type 347
 1
 J-R 316 (elastic unloading compliance method)
 1 C(T)

(2) (6V, 20s)
 1000
 SEM-EDS (energy dispersive spectroscopy)
 SEM(JEOL 6300, 20kV)-EDX(Oxford)
 -ferrite Magne-gage (Ferit- scope, Fisher)

(3)
 ASTM E963-95
 90% methanol-10% HCl
 0.6 A 6~12

3.

1 316°C J-R
 가 1 , SJ SJF 1 dJ/da 175.5
 223.2 MJ/m³
 Type 347 Nb C 10 가 Cr , Nb
 J-R ,
 가 J-R 0.50 wt%
 Type 347 가 2 ,
 -ferrite가 , -ferrite
 가 가
 -ferrite ,
 2 DeLong Cr Ni -
 ferrite 2 Cr_{eq} 가 -ferrite
 -ferrite
 3 J-R SJ , SJF
 SJF SJF
 가 SJF
 -ferrite
 5 a SJF 4
 , b
 SJ SJF , c SJ
 SJ SJF , SJF
 -ferrite가 가 acicular lath
 -ferrite 가 vermicular acicular lath
 -ferrite 가 vermicular 가
 vermicular, 10² K/s vermicular + lath 가 0.1~10 K/s
 가 -ferrite 가 J-R

4.

가 Type 347 J-R
 acicular lath -ferrite가
 vermicular -ferrite가

1. USNRC, USNRC Report NUREG-800, Standard Review Plan. 3.6.3 (1987).
2. W.T. DeLong, The Welding Journal, July (1974), p. 273s-286s.
3. H. Muesch, Nuclear Engineering and Design, Vol. 85 (1985), p. 155-161.
4. P. Balladon and J. Heritier, ASTM STP 905 (ASTM, USA 1986), p. 661-682.
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6. P. Bilmes et al., Revista de Soldadura, Vol. 26, No. 1 (1996), p. 16-30.
7. J. H. Yoon et al., Proceeding of KNSS Fall meeting, Oct. 2002.
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Table 1. The chemical compositions of Type 347 weld metals.

Element Mat.	Fe	Cr	Ni	Mn	Si	Nb	Cu	Mo	C	P	S	N
SJ	Bal.	18.98	10.07	2.28	0.34	0.82	0.25	0.26	0.030	0.020	0.001	0.037
SJF	Bal.	18.99	9.79	2.23	0.36	0.85	0.25	0.25	0.031	0.025	0.001	0.039

Table 2. The δ -ferrite contents in Type 347 weld metals.

Heat	Cr_{eq}/Ni_{eq} *	-ferrite **
SJ	1.56	11.29
SJF	1.56	10.11

*DeLong's equation : $Cr_{eq} = \%Cr + \%Mo + 1.5 \times \%Si + 0.5 \times \%Nb$

$Ni_{eq} = \%Ni + 30 \times \%C + 30 \times \%N + 0.5 \times \%Mn$

** Magnetic measurement (ferrite-gage)

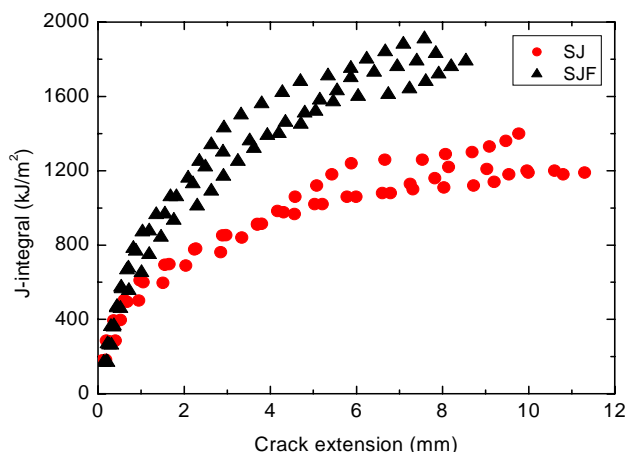


Fig. 1. J-R curves of Type 347 stainless steels welds.

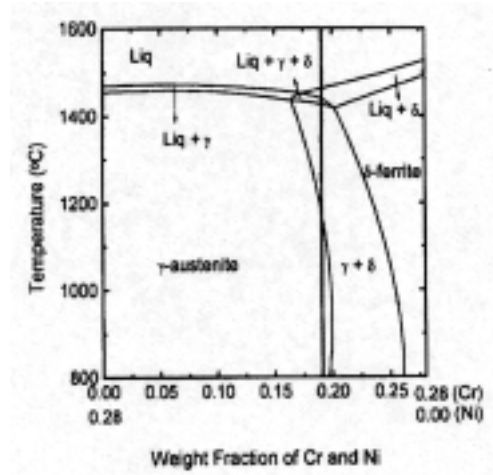


Fig. 2. Phase diagram of the Fe-Cr-Ni -C system at 72 wt% Fe (ref. 8).

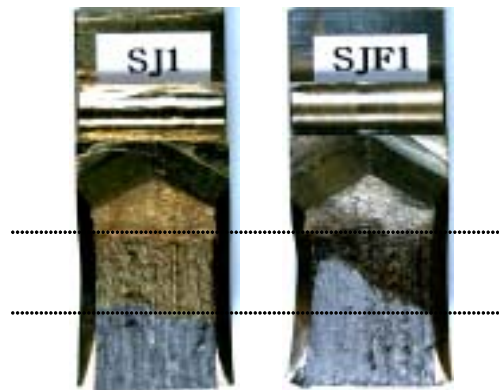


Fig 3. Fracture surfaces of the J-R test specimens

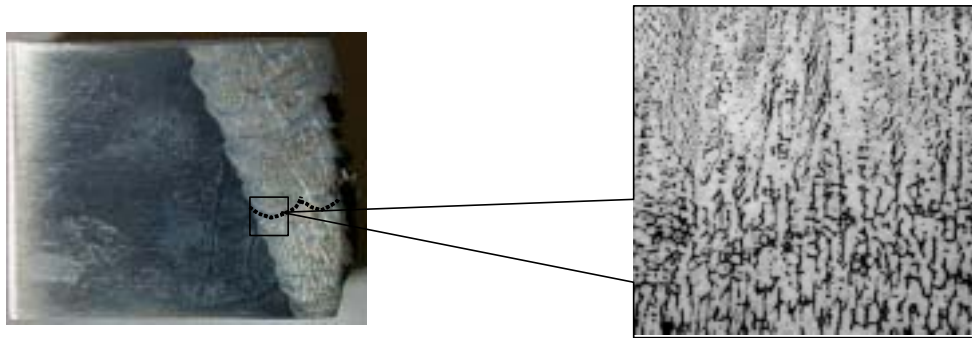


Fig. 4. Microscopy showing solidified weld structure in SJF specimen.

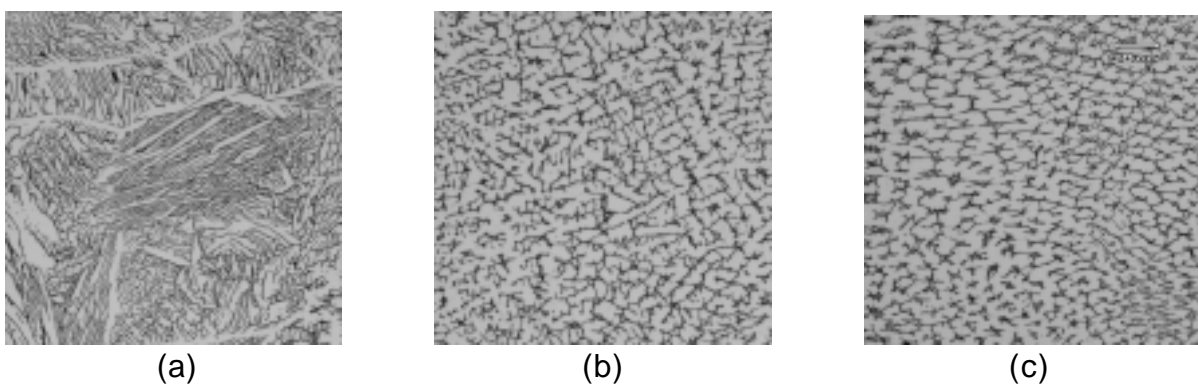


Fig. 5. δ -ferrite morphologies in Type 347 welds ; (a) SJF(high fracture toughness region), (b) SJF(low fracture toughness region) and (c) SJ.