

## Alloy 690 가

## Microstructural Analysis and Estimation of Korean-Made Alloy 690

150

Alloy 690MA ,  
 1 Alloy 690TT .  
 Alloy 690MA (mill annealing) 25  $\mu\text{m}$  , Alloy 690TT 32  
 $\mu\text{m}$  (intergranular stress corrosion cracking, IGSCC)  
 , Alloy 690TT  
 , Alloy 690MA  
 mill annealing  
 Alloy 690 ,  
 Alloy 690 IGSCC

**Abstract**

The microstructure of Korean-made Alloy 690MA was investigated, and the results were compared with those Alloy 690TT in Kori unit 1. The average grain size of Alloy 690MA was measured 25  $\mu\text{m}$ , which is smaller than 32  $\mu\text{m}$  of Alloy 690TT in Kori unit 1. In Alloy 690MA, the intergranular chromium carbides were not significantly evolved during the mill annealing process. However, they were fully precipitated in Alloy 690TT in Kori unit 1. From those results, it was found that the mill annealing condition of Alloy 690MA was not optimized for high resistance to intergranular stress corrosion cracking (IGSCC) in the corrosive environments. To solve those problems, experiments on solution annealing temperature and grain growth behaviors of pilgered Alloy 690 were conducted, and finally found out the optimized conditions for high resistance of Korean-made Alloy 690 to IGSCC.

1.

가 Alloy 600 (Ni-16%Cr-8%Fe) 가 가 가 (intergranular stress corrosion cracking, IGSCC) 가 Alloy 690 (Ni-30%Cr-10%Fe) 1998 8 1 Alloy 690 가 1 Alloy 690 1105 - 1110 2 mill annealing , IGSCC 715 - 730 10 ( thermal treatment TT Alloy 690TT ) IGSCC 가 IGSCC [1] , 가 [2] IGSCC , Alloy 690 Alloy 690MA , 1 Alloy 690TT pilgering Alloy 690 IGSCC

2.

1 (( ) ) Alloy 690 Alloy 690TT 2 가 , 1

Table 1. Chemical compositions of Alloy 690 (wt%)

	Nil	Cr	Fe	C	N	S	Si	Co	Mn	Al	Cu	Ti	P
Alloy 690	bal.	29.2	8.2	0.03	0.027	0.001	0.16	0.02	0.27	0.18	0.01	0.16	0.004
Alloy 690TT	bal.	29.6	10.5	0.02	0.017	0.001	0.22	0.01	0.32	0.02	0.01	0.26	0.009

, SEM (JEOL 5200, 25 kV), Oxford Link (Model ISIS-5947)가 TEM (JEOL 2000FX-II, 200 kV)

10 % HNO<sub>3</sub> + 90 % ( nital) , 3 V,  
 10 – 30 SEM ,  
 2 % bromine + 98 %  
 15 % H<sub>3</sub>PO<sub>4</sub> + 85% 3 V  
 TEM 가 60 μm , 7 % HClO<sub>4</sub> +  
 93 % - 40 , 가  
 50 mA 가 가 .

### 3.

#### 3.1 Alloy 690MA 1 Alloy 690TT

Alloy 690MA , 25 μm . [3]  
 1 SEM  
 , TEM  
 , chromium-rich (Cr-rich) M<sub>23</sub>C<sub>6</sub>  
 가 SCC  
 . [4]

1 Alloy 690TT

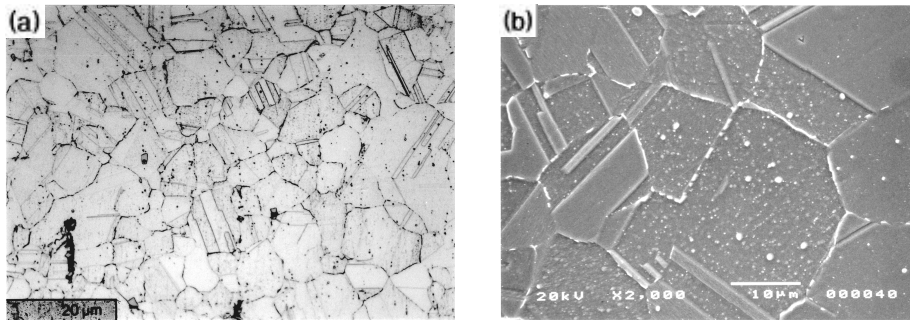


Fig. 1 (a) Optical and (b) SEM micrographs of Korean-made Alloy 690MA, etched in 2 % bromine + 98 % methanol.

2(a) Alloy 690TT SEM , (b) TEM  
 32 μm ,  
 2(a) , Alloy  
 690MA Alloy 690TT 2(b)

TEM Alloy 690MA  
 Cr-rich  $M_{23}C_6$   
 cube-cube  $\{100\}_{ppt} // \{100\}_{matrix}$   $\langle 100 \rangle_{ppt} // \langle 100 \rangle_{matrix}$   
 [5]

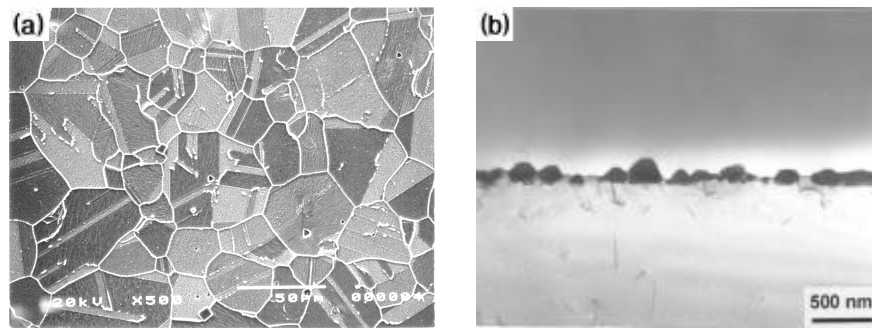


Fig. 2 (a) SEM micrograph and (b) TEM bright filed image of Kori Alloy 690TT, showing intergranular Cr-rich  $M_{23}C_6$ .

### 3.2 Alloy 690

3.1 Alloy 690MA mill annealing  
 가 74.3 % 가 (cold pilgering) 3(a),  
 (b) 가  
 , , rolling  
 가 slip band , 가 rolling

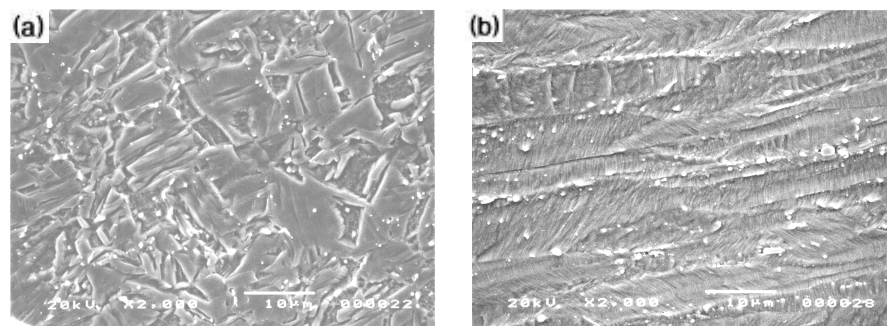


Fig. 3 SEM micrographs showing intergranular carbides (a) in the transverse cross section and (b) in the longitudinal cross section of as-pilgered Alloy 690.

Alloy 690 IGSCC

32  $\mu\text{m}$  [6] mill annealing pilgering TT

가 1 가 1200 1

가 가 가 가

4(a), (b) 가 1105 , 1108 1 가

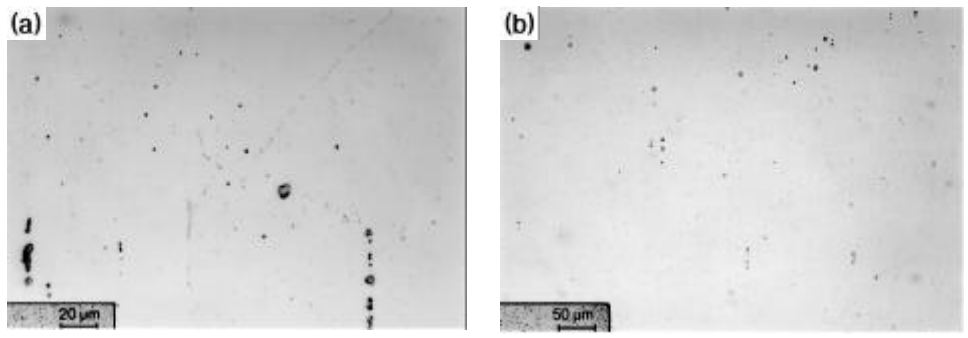


Fig. 4 Intergranular carbide morphologies in Alloy 690 heat treated at 1200 for 1 hour followed by subsequent heat treatment (a) at 1105 and (b) at 1108 for 1 hour, etched in 15 %  $\text{H}_3\text{PO}_4$  + 85% distilled water.

1105 , 가 1108 1106 – 1107

5(a) , pilgering 1130 20 morphology 5(b)

5(b) , power law , thermal activation process Arrhenius equation . [7]

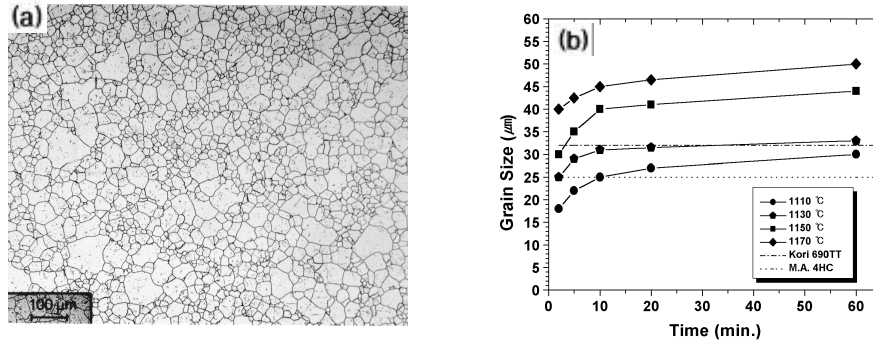


Fig. 5 (a) Optical micrograph of Alloy 690 heat treated at 1130 °C for 20 min., etched in a nital solution and (b) grain size variation as a function of heat treatment temperature and time.

### 3.3 Alloy 690

가 Alloy 690 IGSCC  
 . [7] , Alloy 690MA  
 690TT 32 μm , 25 μm  
 Alloy 690MA mill annealing

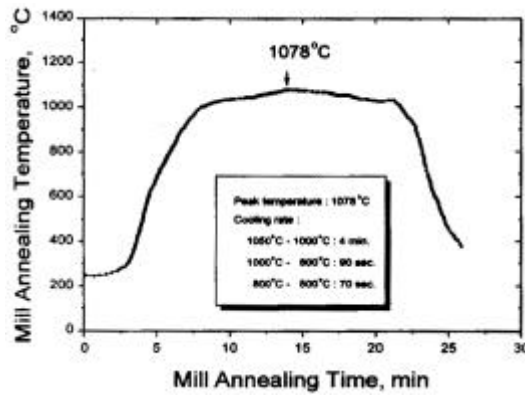


Fig. 6 Temperature profile of mill annealing process of Alloy 690

