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THE INFLUENCE ON CORROSION WITH RESIDUAL STRESS AND TRANSFORMATION INDUCED IN SHOT-PEENED AUSTENITIC STAINLESS STEEL

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Abstract

This paper describes the effects of shot peening for corrosion on stainless steel.

Shot peening were performed to austenitic stainless steel, SUS304 by air type peening machine. Obtained factors are austenitic volume, residual stress, half width and corrosive resistance.

Shot peening has the effect of corrosive resistance on intergranular corrosion.

Keyword : Austenitic Stainless Steel, Shot Peening, Work-induced Transformation, Residual Stress、 Corrosive Resistance

1. Introduction

Stainless steel invented in the twentieth century, and manufacture process are developing. Especially austenitic stainless steels was widely used in various such as mechanical, chemical, atomic, medical, offshore structure and so on. At present, various stainless steels developed to accomplish various purpose.

In heavy corrosive environment, stainless steels are used as the metal required much more corrosive resistance[1). If the surface treatment by shot peening improve corrosive resistance and mechanical property, shot peening is a useful.

2. Experimental Procedures and Equipments

2.1 Specimen

Specimens in this study were produced from austenitic stainless steels (SUS304). The size and shape was shown in Fig.1. Shape of specimen is ϕ16×16mm. All specimens were treated stress relief annealing in vacuum, because of removing influence working, removing oxidizing film and producing uniform structure. Treatment was shown in Fig.1.

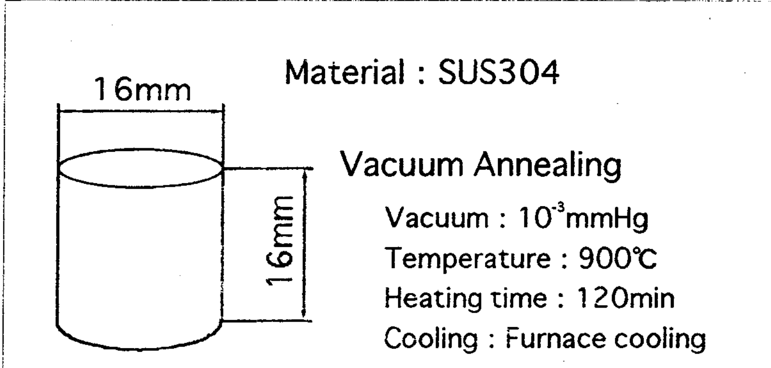


Fig.1 Specimen and Heattreatment

2.2 Shot Peening

Specimen was peened by three type shot; steel, ceramic, and glass. Conditions of shot peenig, heat treatment, and corrosive solutions were shown in Tab.1, and arc heights were shown in Tab.2.

Shot peening	Shot	steel, ceramic, glass
	Diameter	0.92mm, 0.18mm
	Peening time	Tf (full coverage)
	Pressure	1, 2, 3atm
	Equipment	Air type
Heat treatment	Heating temperature	100~600℃
	Heating time	60min
	Equipment	Vacuum furnace
Corrosive solution (per 1 ℓ)	Intergranular corrosion (room temperature)	HNO_3 10% +HF 3%
	Pitting corrosion (room temperature)	$FeCl_3$ 100g +HCl 5%

Tab.1 Experiment Conditions

2.3 Measurements

Austenitic volume and residual stress were measured by X-ray diffraction method, and distributions were obtained by window-method. Window size is 4×4mm.

2.4 Corrosive test

Corrosive test was performed static immersion under room temperature, and performed on the intergranular and on the pitting. Composition of corrosive solutions were shown in Tab.1[2),3)]. Microphotograph of surface after corrosion was shown in Fig.2 and Fig.3.

Shot	Diameter	Pressure	Arc height (mm)
steel	0.92mm .037"	1atm	0.33A ,013"
		2atm	0.48A .019
		3atm	0.67A ,027
	0.18mm	3atm	0.12A .005
ceramic	0.92mm .007"	3atm	0.61A .024
	0.18mm	3atm	0.11A .004
glass	0.92mm	3atm	0.60A .024

Tab.2 Arc height

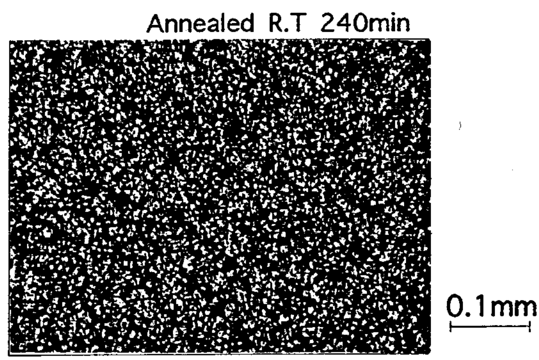


Fig.2 The surface after intergranular corrosion

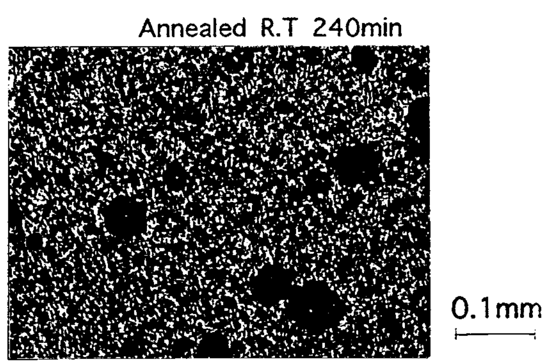
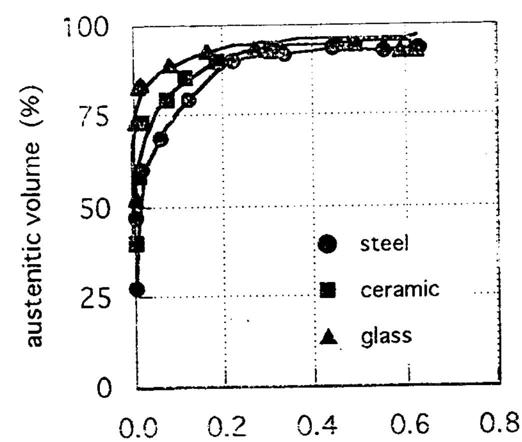


Fig.3 The surface after pitting corrosion



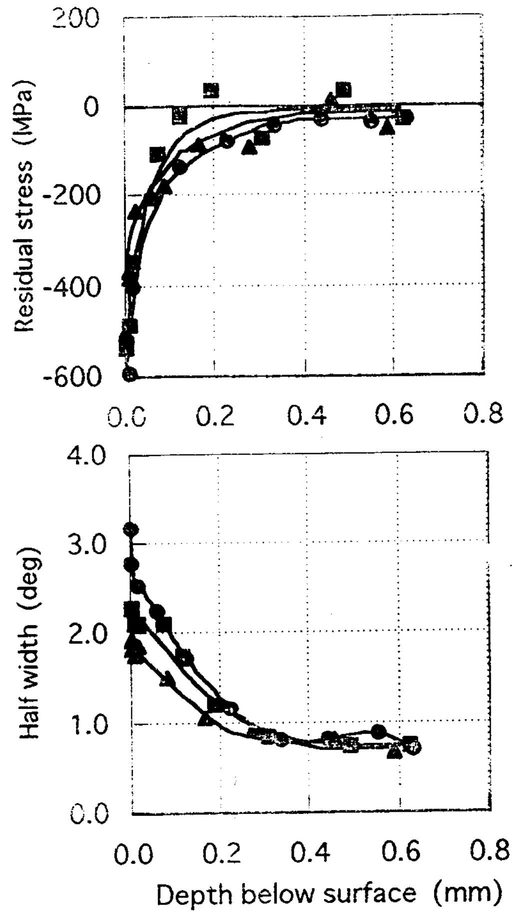


Fig.4 Distributions induced by three shots (ϕ0.92mm, 3atm)

3. Results

3.1 Influence of residual stress and transformation by shot peening

Shot peening was performed by three shots; steel, ceramic and glass and by three air pressures; 1, 2, 3atm. As the second experiment, specimen was heated removing the affected zone induced by shot peening.

Fig.4 shows distributions of austenitic volume, residual stress and half width. Shot diameter was 0.92mm. Steel shot was much influenced for distribution of austenitic volume, but residual stress was not so influenced by the quality of shot.

φ0.92mm, 3atm

	Transfor-mation (%)	Residual stress (MPa)	Half width (deg)	Arc height (mm)
steel	72.68	-591.3	3.185	0.67A
ceramic	60.01	-538.6	2.293	0.61A
glass	47.93	-501.1	1.932	0.60A

Tab.3 Influence by 3 shots

φ0.92mm, steel

	Transfor-mation (%)	Residual stress (MPa)	Half width (deg)	Arc height (mm)
1atm	53.30	-240.7	2.017	0.33A
2atm	63.23	-312.2	2.447	0.48A
3atm	72.68	-591.3	3.185	0.67A

Tab.4 Influence by 3 pressures

Distributions of austenitic volume, residual stress and half width were shown in Fig.5 under three peening pressures. In this case, shot is only steel and diameter is 0.92mm. As for transformation, 3atm was influenced deeply. And all distributions have the largest value at surface.

Fig.6 shows the influence of heat treatment on surface values by 60 minutes heating after shot peening. All values were decreased by heating and reached annealed values at 600℃.

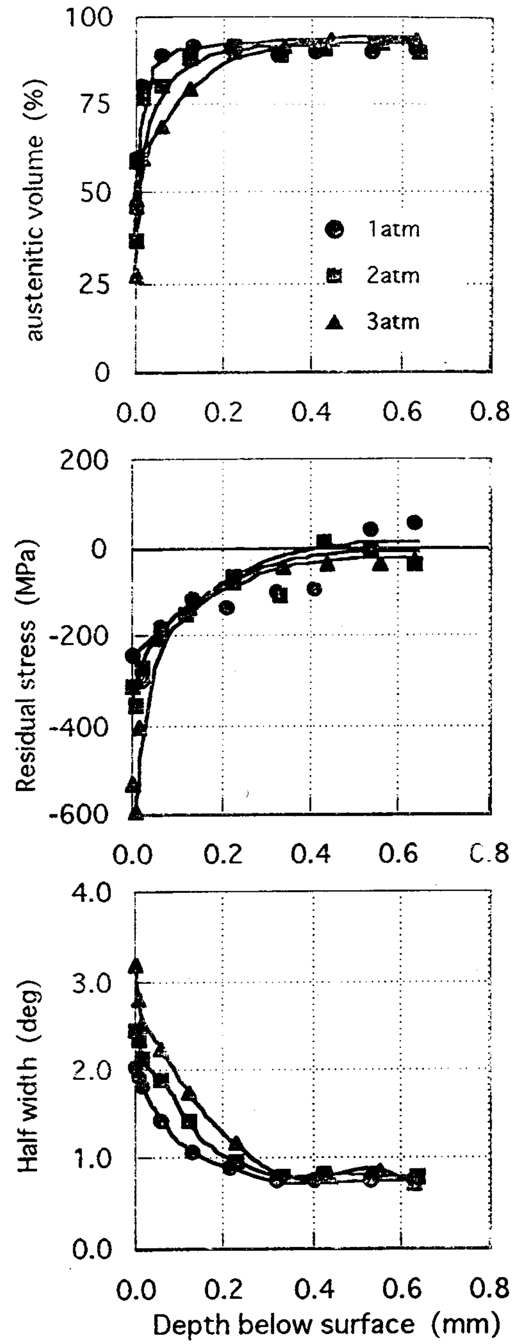


Fig.5 Distributions induced by three pressures (φ0.92mm, steel)

3.2 Characteristic of corrosion

The sort of corrosion of stainless steel is intergranular and pitting. Detail of corrosive solutions was shown in Tab.1. For removing the affected zone produced by shot peening, and for comparing under the same roughness of specimens, they were annealed after shot peening.

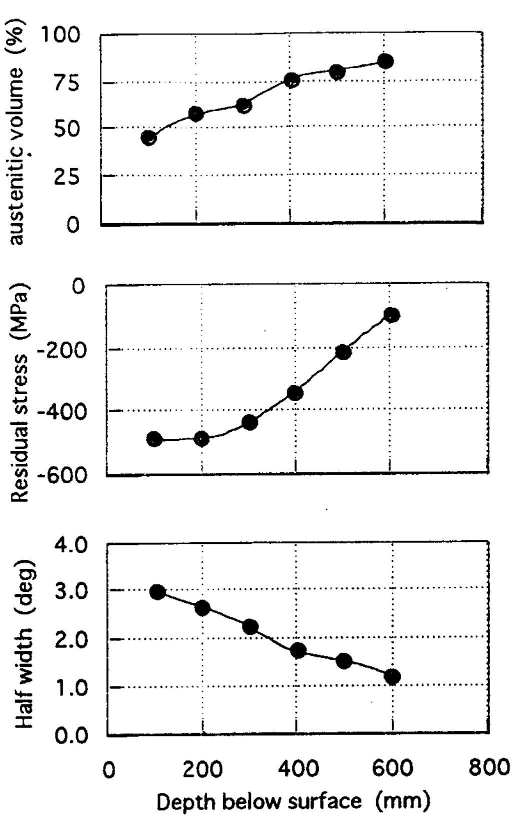


Fig.6 Influence of heat treatment for 60 minutes after peening (ϕ0.92mm, steel, 3atm)

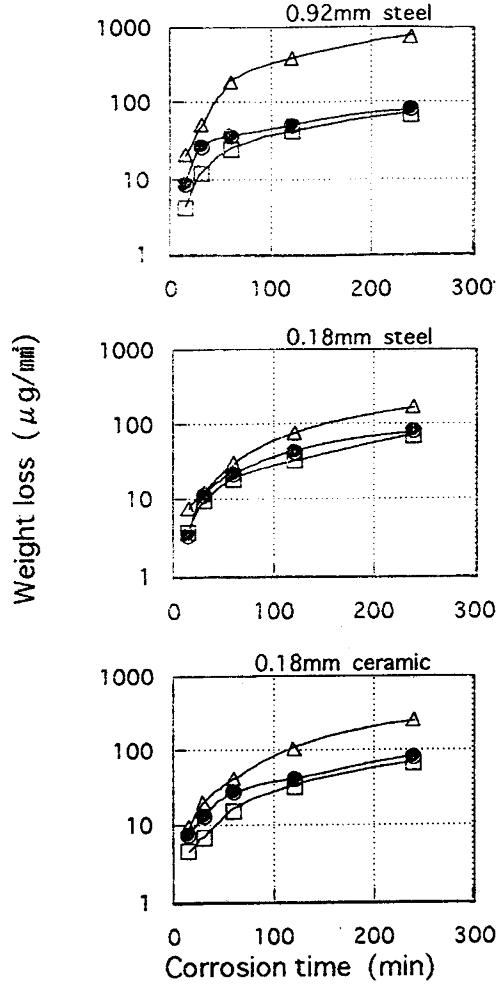


Fig.7 **Influence of shot peening and heat treatment on intergranular corrosion**

3.2.1 Property of intergranular corrosion

Weight loss per unit area on intergranular corrosion was shown in Fig.7 and Fig.8. Fig.7 are the result of comparison on three specimens. Peened specimen was the most least weight loss, on the other hand, heat treated specimen was the largest. Thus, it was found that shot peening improves intergranular corrosive resistance.

In Fig.8 another viewpoint for corrosion was shown, and the peened specimen by 0.92mm shot was the most corroded.

3.2.2 Property of pitting corrosion

Weight loss per unit area on pitting corrosion was shown in Fig.9.

In this experiment, it was found that shot peening didn't affect pitting corrosive resistance.

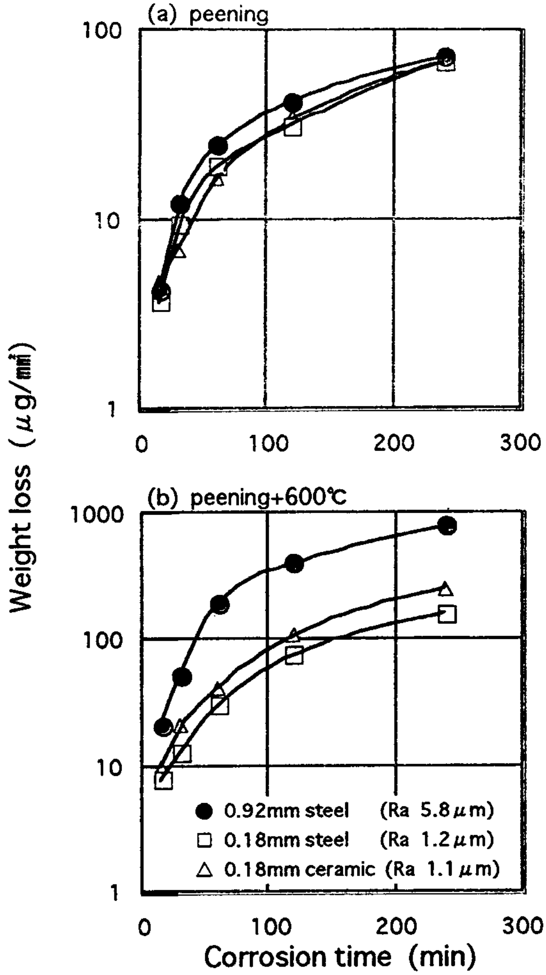


Fig.8 Influence of shot peening and heat treatment on intergranular corrosion

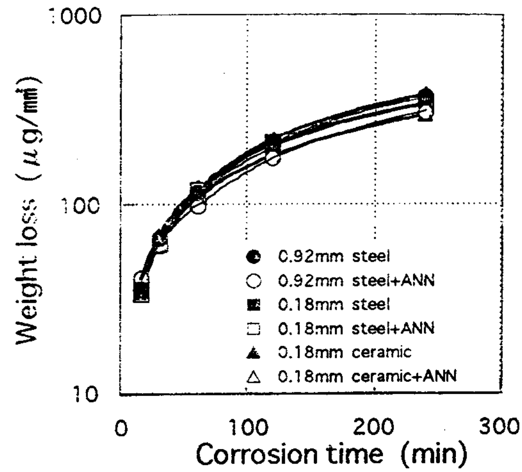


Fig.9 Influence of shot peening on pitting corrosion

4. Conclusions

1) On the stainless steel, work induced transformation was produced by shot peening.

2) Corrosive resistance of intergranular was improved by shot peening, and the most improvement was 17.3% in this experiment. But shot peening didn't affected pitting corrosive resistance.

3) Shot peening effect for corrosion was removed by heat treatment over 600℃.

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5. References

1) Hiroshi Taira : Elementary and practical stainless course. (1976) 15,16

2) Masayoshi Hasegawa : Summary of stainless steel. (1979) 935,949

3) Society of material of Japan : Technology of corrosive resistance of material. (1969) 63