Development of Material for Fuel Tank "SZ-GTX"

by

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Synopsis

Lead-Tin(Pb-Sn) plating is regularly used as a material for the fuel tanks of motor vehicles. However, a movement to investigate "post-Pb-Sn" materials gained ground after the effect of shredder dust regulations in April 1996. We tried to apply Zn-Ni alloy in fuel tanks, eventually developing "SZ-GTX" with excellent after-forming corrosion resistance and excellent anti-fuel corrosion resistance. We introduce the product's performance.

1. Preface

Lead-Tin(Pb-Sn) plating is regularly used as a material for the fuel tanks of motor vehicles. However, a movement to investigate "post-Pb-Sn" materials gained ground after the effect of shredder dust regulations in April 1996. We tried to apply Zn-Ni alloy in fuel tanks, eventually developing "SZ-GTX" with excellent after-forming corrosion resistance and excellent anti-fuel (gasoline, gasohole) corrosion resistance. We introduce the product's performance.

2. Film Composition

The film composition of SZ-GTX is the double layers as shown in **Fig. 1**. The under layer is the Zn-Ni alloy electroplating film which includes 10-16% Ni. This Zn-Ni alloy electroplating film is specially treated. The upper layer is the chromate film which completely covers the Zn-Ni layer in order to keep high corrosion resistance.

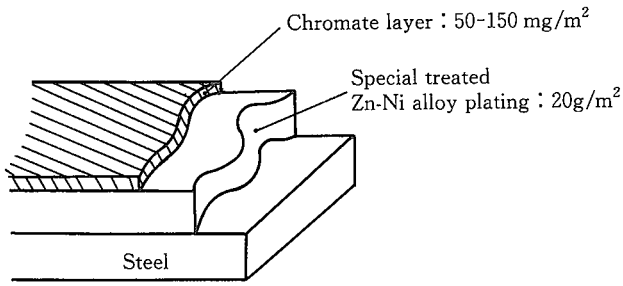


Fig. 1 The film composition of SZ-GTX

3. Product's Performance

The sample's details are shown in **Table 1**. The estimation in performance of SZ-GTX is shown in **Table 2**. SZ-GTX has a excellent performance as compared with Pb-Sn plating and EG-chromate which are used as gasoline tank now.

Table 1 Test sample's details

Sample	Thickness (mm)	Plating weight (g/m^2)	Plating composition	Chromate weight (mg/m^2)	Notes
SZ-GTX	0.8	20	Ni%=12	100	Developed material
Pb-Sn plating	0.8	45	Sn/Pb=0.09	—	Material on the market
EG chromate	0.8	41	—	55	Labo treated material

Table 2 Estimation in performances of SZ-GTX

Performance		SZ-GTX	Pb-Sn plating	EG chromate
Corrosion resistance (Salt spray test)	As flat panel	◎	○	△
	After 30% stretching	◎	△	$△^+$
	After cup drawing	◎	△	$△^+$
	After scribed by knife	◎	△	$△^+$
Corrosion resistance in gasoline	Gasoline + 5% NaCl aq.	$○^+$	○	$○^-$
	Gasoline(85%)+ Methanol(15%)+Formic acid	○	○	$○^-$
Formability	Friction coefficient	$○^+$	○	○
Weldability	Brazing	○	—	○
	Seam welding	$○^+$	$○^+$	○

◎ : Excellent, $○^+$: Good, ○ : No problem(Basis), △ : Not good

3.1 Flat Panel Corrosion Resistance

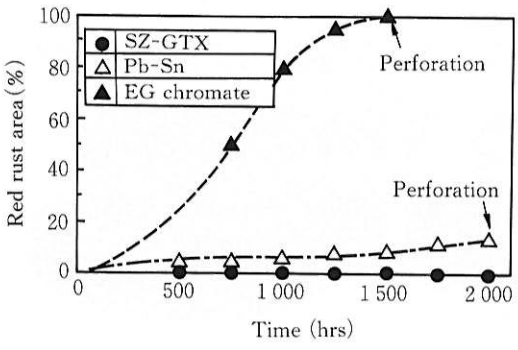
The red rust result of salt spray test by JIS Z2371 is shown in **Fig. 2**. SZ-GTX has no red rust after 2 000 hrs SST, which shows excellent corrosion resistance.

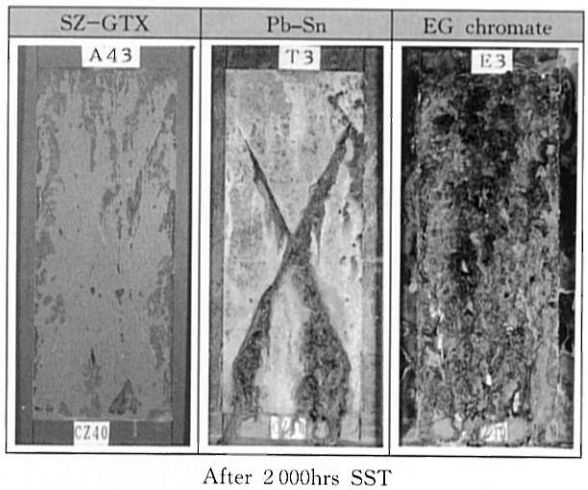
3.2 Corrosion Resistance After Forming

3.2.1 Corrosion Resistance After 30% Stretching

Maximum corrosion depth result of salt spray test by JIS Z2371 after 30% stretching is shown in **Fig. 3**.

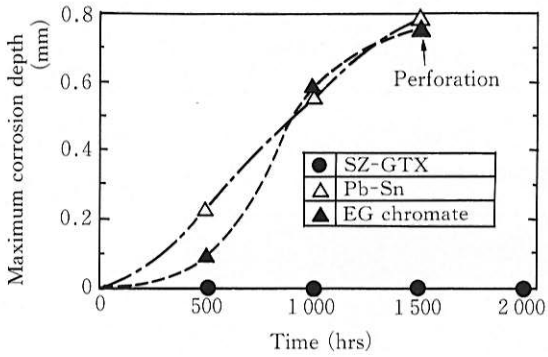
SZ-GTX has no corrosion depth after 2 000 hrs SST, which shows excellent corrosion resistance.

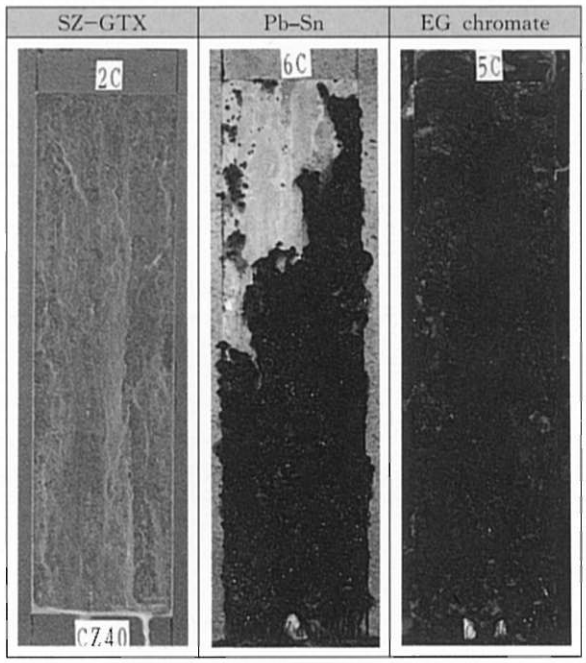




After 2 000hrs SST

Fig. 2 Corrosion resistance as flat panel (Salt spray test)



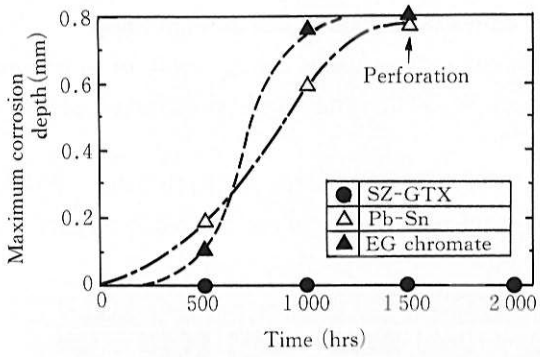


After 1 500hrs SST

Fig. 3 Corrosion resistance after 30% stretching (Salt spray test)

3.2.2 Corrosion Resistance After Cup Drawing

Maximum corrosion depth result of salt spray test by JIS Z2371 after cup drawing is shown in **Fig. 4**.



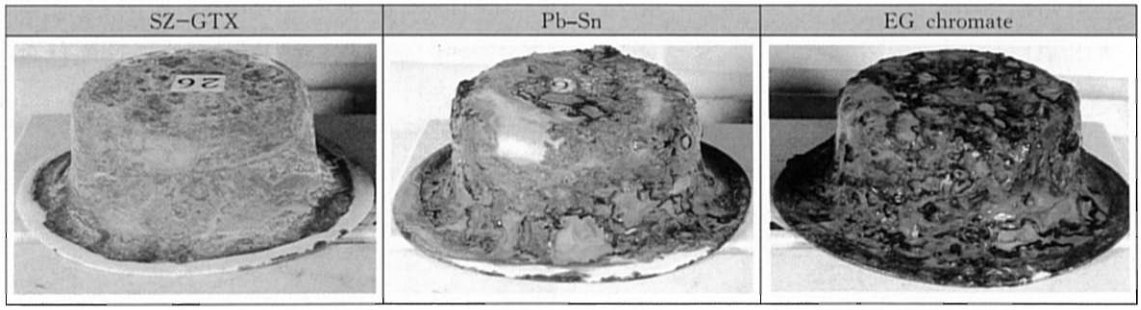
SZ-GTX has no corrosion depth after 2 000 hrs SST, which shows very excellent corrosion resistance.

(Cup drawing condition)

Blank diameter=100mmϕ, Punch diameter=50mmϕ, (drawing ratio=2), Die diameter=52mmϕ, Blank holder force=10kN, Drawing height=25mm

3.3 Corrosion Resistance After Scribed by Knife

Appearance of corrosion result of salt spray test by JIS Z2371 after scribed by 0.4mm knife is shown in **Fig. 5**. SZ-GTX has no red rust till 1 500 hrs SST, which shows good corrosion resistance.



After 1 500hrs SST

Fig. 4 Corrosion resistance after cup drawing (Salt spray test)

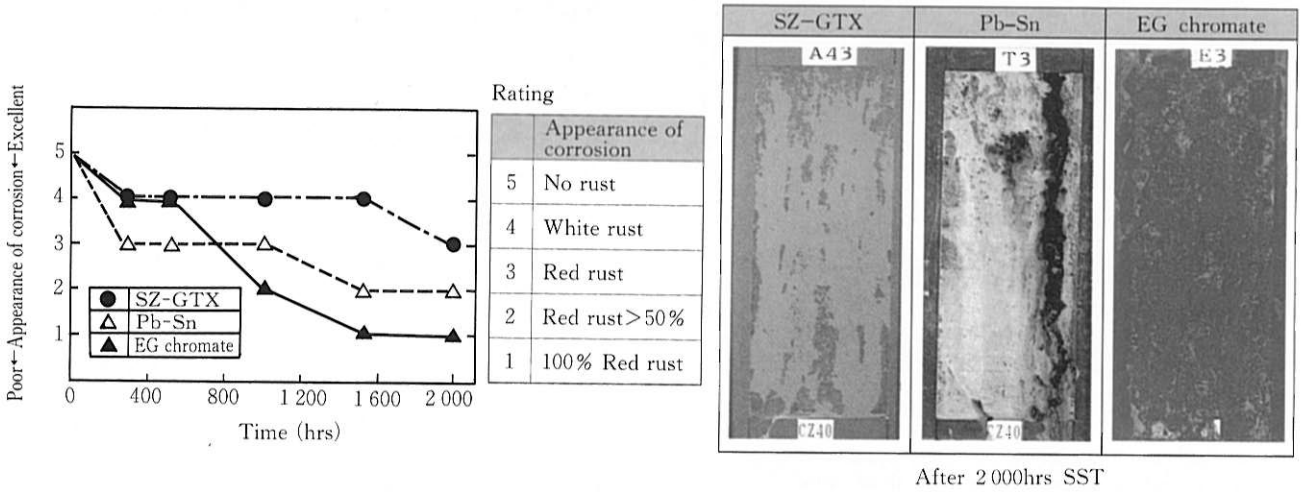


Fig. 5 Corrosion resistance after scribed by knife (Salt spray test)

3.4 Corrosion Resistance in Gasoline

Corrosion resistance in gasoline is evaluated by the appearance after 180days and the maximum corrosion depth of samples which are drawn by followiong condition and are filled with 30ml of gasoline and 1ml of 5% NaCl aq. The method and result of corrosion resistance in gasoline is shown in **Fig. 6**. The maximum corrosion depth result is shown in **Fig. 7**.

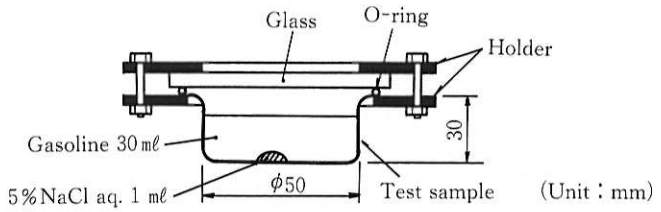
As compared with that EG-chromate has severe red rust and Pb-Sn plating has dotted red rust, SZ-GTX has no red rust and light white rust, which shows good corrosion resistance.

The dissolved metal concentration in gasoline and NaCl aq. is shown in **Fig. 8**.

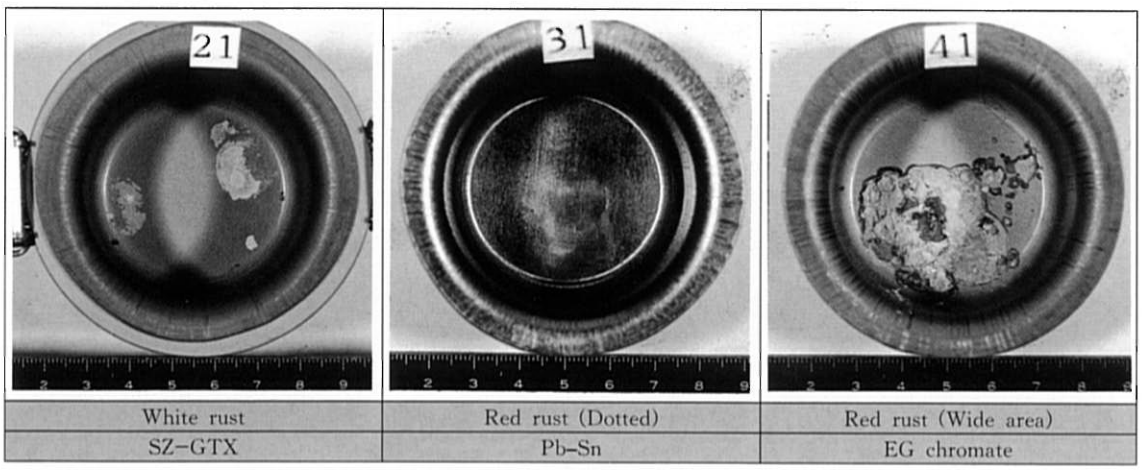
Zn of SZ-GTX dissolves a little in NaCl aq., but SZ-GTX is better corrosion resistance than EG-chromate.

(Cup drawing condition)

Blank diameter=100mmϕ, Punch diameter=50mmϕ, (Drawing ratio=2), Die diameter=52mmϕ, Blank holder force=10kN, Drawing height=30mm



(Test method)



(Result)

Fig. 6 Method and result of corrosion resistance in gasoline (After 180 days)

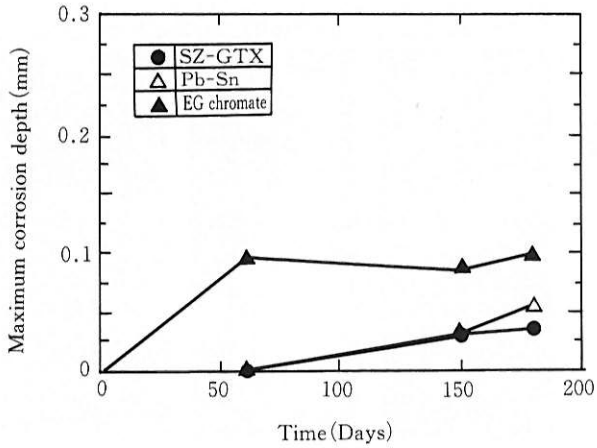


Fig. 7 Maximum corrosion depth after corrosion resistance in gasoline

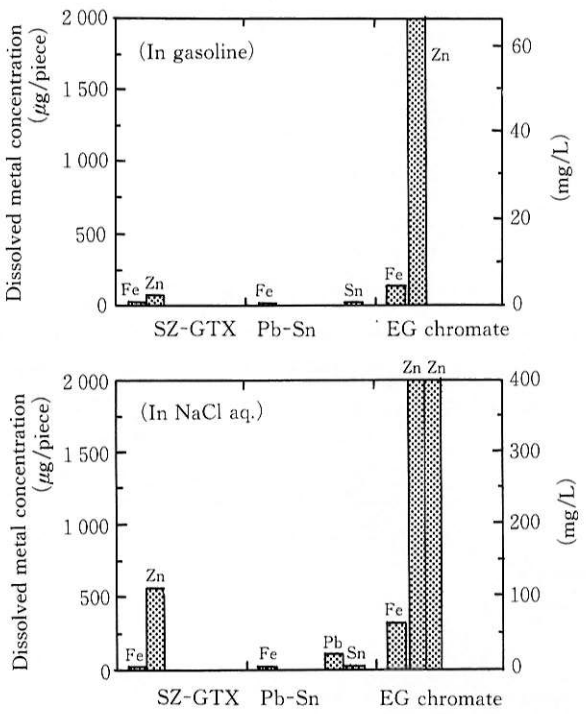


Fig. 8 Dissolved metal concentration in gasoline and NaCl aq.

3.5 Corrosion Resistance in Gasohole

Lately,by the automobile emission control regulations which considers the environmental problem, gasoline/alcohol mixed fuel(ex.M15 which includes 15% methanol) that is called as gasohole,is researched in some countries, so we investigate the corrosion resistance of SZ-GTX in gasohole.

Sample are drawn by same condition as the corrosion resistance test in gasoline.

After that samples are filled with 30ml of M15 (gasoline which includes 15% methanol and 0.3% formic acid). The appearances after 180days are shown in **Photo 1**.

EG-chromate has white rust in wide area, and Pb-Sn plating has dotted red rust in wide area. But SZ-GTX has no red rust and very light white rust in small area.

3.6 Formability

3.6.1 Friction Coefficient

To evaluate formability, the test method and result of friction coefficient are shown in **Fig. 9**. The friction coefficient of SZ-GTX is very lower than Pb-Sn plating and EG-chromate. The reason is that the film of SZ-GTX is harder than that of Pb-Sn plating and EG-chromate and is difficult to be damaged. So, we understand SZ-GTX has the excellent formability.

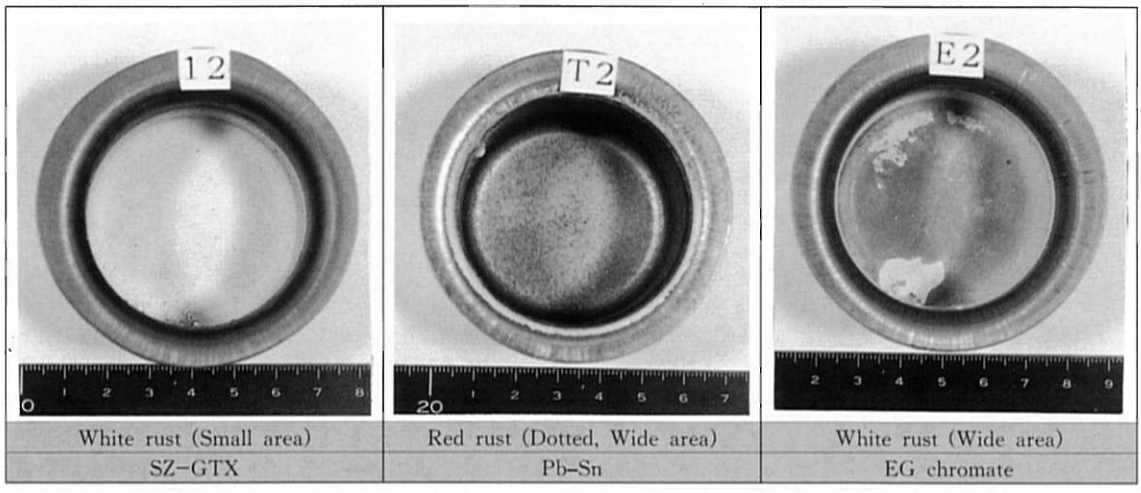
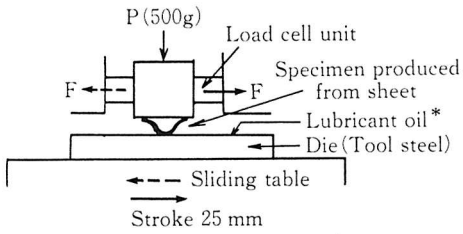


Photo 1 Corrosion resistance in gasohole (After 180 days)



*Viscosity : 15 cst (40℃)

(Modified Bowden test procedure)

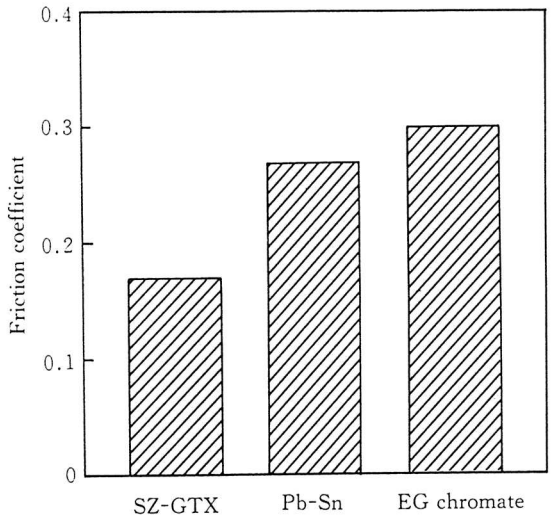


Fig. 9 Test method and result of friction coefficient

3.6.2 Anti-Powdering Resistance

Sometimes plating sheet has weak powdering resistance and obstruct forming, so we checked powdering property. **Figure 10** shows powdering weight under the following cup drawing condition. Powdering weight of SZ-GTX is fewer than Pb-Sn plating or EG chromate. SZ-GTX is good for forming.

(Cup drawing condition)

Blank diameter=100mmϕ, Punch diameter=50mmϕ, (Drawing ratio=2), Die diameter=52mmϕ, Blank holder force=10kN, Drawing height=25mm

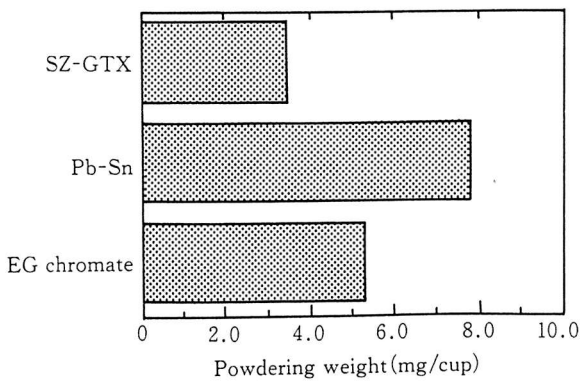


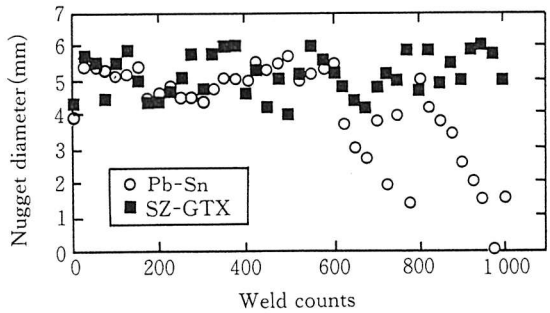
Fig. 10 Powdering property after cup drawing

3.7 Weldability and Brazing Property

3.7.1 Spot Weldability

To evaluate spot weldability, we investigated the consecutive spot welding test.

Figure 11 shows the result of concecutive spot weldability. Pb-Sn plating doesn't form the normal nugget over 600 counts, meanwhile SZ-GTX form the normal nugget over 1 000 counts. SZ-GTX has good spot weldability.



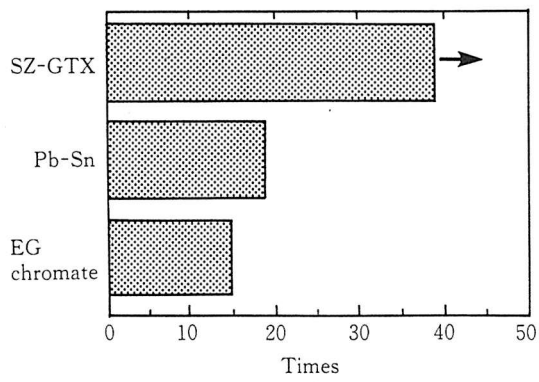
(Welding condition)

Electrode	: WR type
Welding current	: 10 kA
Power supply	: C type
Electrode force	: 220 kgf
Welding time	: 10 cycles

Fig. 12 Seam weldability

3.7.2 Seam Weldability

When conjuncting the upper tank with the lower tank, we use seam welding method. We do the 600 mm seam weld at once, we investigated the nugget and evaluated the welding counts at which the nugget diameter is smaller than the basis nugget diameter. The nugget diameter about Pb-Sn plating or EG chromate doesn't form the basis nugget diameter under 20 welding counts. But the nugget



(Welding condition)

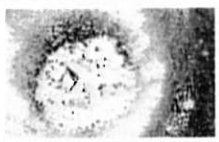
Electrode	: R type
Welding current	: 13 kA
Electrode force	: 300 kgf
Welding length	: 600 mm/time
Welding pattern	: ON-OFF pattern 3-2 cycles

Fig. 11 Consecutive spot weldability

diameter about SZ-GTX forms the bigger nugget diameter than the basis nugget diameter over 40 welding counts. SZ-GTX has good seam weldability.

3.7.3 Brazing property

When conjuncting small pipes with the tank, brazing method is used. Brazing property is evaluated by getting wet property of Ag-Cu brazing. The result is shown in **Photo 2**. SZ-GTX has better brazing property than Pb-Sn plating.

Sample	Appearance	Wettability
SZ-GTX		○
Pb-Sn		△
EG chromate		○

Brazing filler metal : Ag-Cu type
(Melting point 870~880℃)
Flux : $ZnC\ell_2$ type

Photo 2 Brazing

4. Conclusion

SZ-GTX has excellent after-forming corrosion resistance and excellent anti-fuel corrosion resistance(anti-gasoline property, anti-gasohole property).

We discover SZ-GTX is the promising fuel tank material that is good for environment and is substitute for Pb-Sn plating.

Now we are trying to investigate the practical use to the actual fuel tank.

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