SiOC COATING ON STS316 BY SOFT SOLUTION METHOD WITH POLYPHENYLCARBOSILANE, AND ITS ANTI-CORROSION PROPERTIES

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Introduction

The ceramic coating on metal has been interested for its chemical resistance including oxidation resistance and strength in high temperature [1, 2]. In such aspect, SiC is a promising material to be used as protective coating layer on metal due to its outstanding thermal stability and hardness. Especially the SiC coating method by solution process using polycarbosilane [3], which is Cl free preceramic polymer, is very useful method economically and environmentally.
In Riedel, R. et al's work, polycarbosilane oxidizes in air through heat treatment, and can derive Si-O-C ceramics[4] in lower temperature. The SiOC network, carbon-containing glasses, indicates improved the thermal and mechanical properties than fully oxide related systems [5]. Polyphenylcarbosilane which is one of carbosilane polymer can be an advanced preceramic polymer for SiOC ceramics with rich carbon. Through the thermal process Si-O-C network can be formed

In this research, SiOC film was coated onto the metal substrate and focused its anti-corrosion effect in strong acid. The SiOC coating was carried out onto STS 316 by dip coating method with polyphenylcarbosilane solution in which SiC nano powder suspended. And each Si, O and C atoms were networked through pyrolysis in air atmosphere. The anti-corrosion effect of the SiOC film was tested in 10wt% HCl solution for one week.

Experimental

Materials
Polyphenylcarbosilane(PPCS) was supplied by TBM Tech. Co., and it's chemical structure is shown in Fig. 1 [6]. SiC powder with 130nm size on average was supplied by Accument Materials Co. The coating solution was prepared as 20wt% PPCS solution in toluene, and SiC powder was suspended as 10wt% and 15wt% each. STS 316 was chosen as the coating substrate.

Coating process
SiC powder suspended PPCS solution was coated on STS 316 with dip coating method. After curing PPCS film at 200℃ in the air heat, treatment was proceeded at 800℃ in nitrogen atmosphere to derive SiOC film.

Apparatus and Procedures
The hardness of SiOC films were tested by pencil test with 9H pencil and the loading condition with 800g. The corrosion test was carried out by socking the STS 316 plates in 10wt% HCl solution for 7 days

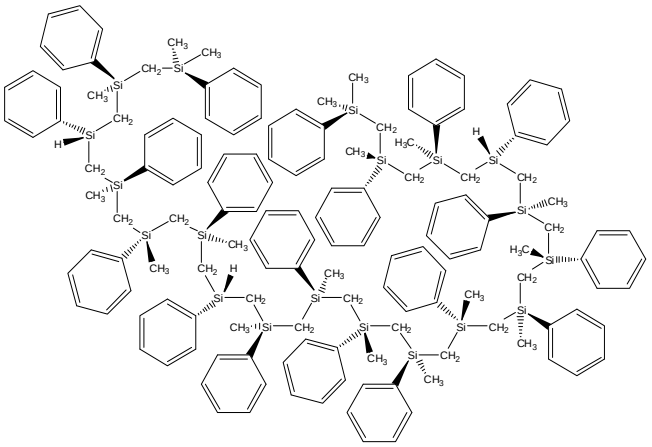
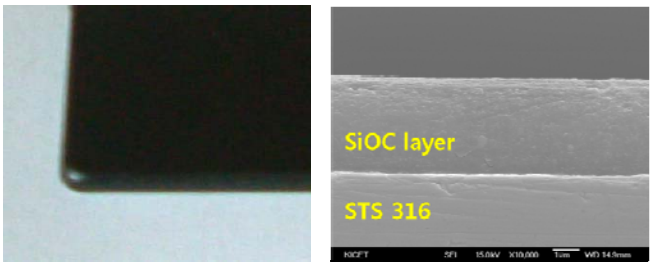


Fig. 1 Structure of polyphenylcarbosilane(PPCS)[6]

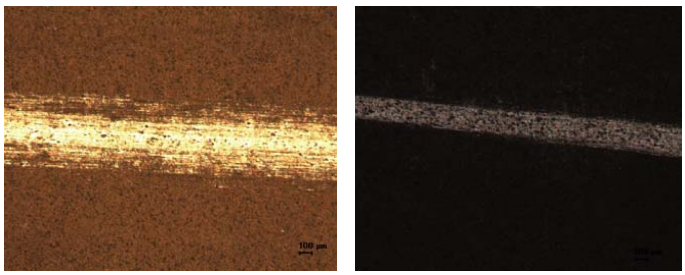
Results and Discussion

SiC nano powder was used with the intention to prevent the crack which can be caused by the shrinkage through the pyrolysis of the polyphenylcarbosilane. After the coating process the black SiOC coating films were formed as 3㎛ thickness on the metal surface. Through the cross-sectional SEM image, SiOC film shows good adhesion properties on the metal surface (Fig. 2) without any cracks. The SiC nano powder can be worked as good additive for formation of crack free SiOC films.
The adhesion and the strength of SiOC film also can be confirmed from pencil hardness test with 9H pencil. From the result (fig. 3) the SiOC film can stand up to 800g loading without any defect on surface and any exfoliation from the substrate.



(a) (b)

Fig. 2 (a) SiOC film coated STS 316 and (b) cross-sectional SEM image of SiOC film on STS 316

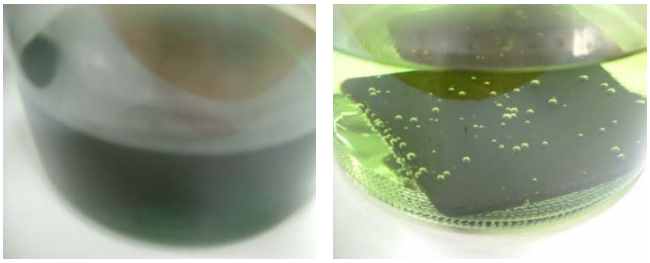


(a) (b)

Fig. 3 Optical image after pencil test on SiOC film formed (a) including SiC powder as 10wt% and (b) as 15wt%

For the anti-corrosion effect test, the SiOC coated plate was socked in 10wt% HCl. As the fig. 4 (b), the test solution with SiOC coated plate has been remained as clear solution even though the solution was turned green that was caused corrosion partially. On the other hand the test solution with non coated metal (Fig. 4 (a)) had become dark solution caused by corrosion effect.

The fig. 5 shows anti-corrosion effect of SiOC films on metals with weight loss for one week comparing with non coated metal. From the fig. 5 the weight-loss of SiOC coated metal was reached less than 2wt% for one week, but the non coated metal plate lost the weight up to about 10% for corrosion in acid.



(a) (b)

Fig. 4 Corrosion test in HCl solution of (a) STS316 without any coating and (b) STS 316 on which SiOC film was formed

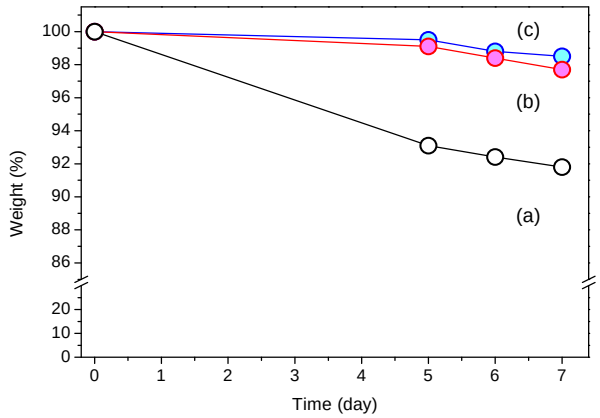


Fig. 5 Variation rate of weight after corrosion test, (a) STS 316 without any coating, (b) SiOC film with 10wt% of SiC and (c) SiOC film with 15wt% of SiC on STS 316

Conclusion

SiOC coating layers which were derived from the polyphenylcarbosilane solution with suspended SiC nanopowder were successfully formed with good adhesion on metal surface and without any defect. From the corrosion test in 10% HCl solution, it shows that the SiOC is good coating materials to prevent the corrosion of metals in strong acid.

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