

DENSIFICATION OF CERAMIC COMPOSITE FILMS COATED ON STEEL BY WET PROCESS

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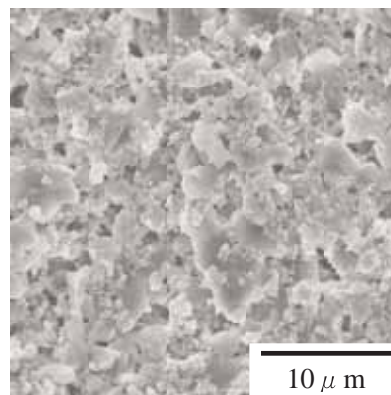
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Ceramic coatings on metals have been developed for various industrial applications to inhibit corrosion, erosion or abrasion, or to endow the metal works with a decorative color. So far most of the coatings have been realized by costly dry processes using large-scale equipments and wet processes for ceramic coatings, in contrast, have been scarcely studied well. Under this situation, we found a promising way to deposit a ceramic film (80-100 μm thick) on metals (steel, copper, etc.) by a wet process. The ceramic composite film deposited on steel consisting of several inorganic materials (Al_2O_3 , SiO_2 , TiO_2 etc.), exhibited fairly good adhesion strength and thermal stability in air at temperatures below 600 $^\circ\text{C}$ at 700 $^\circ\text{C}$ and above, however, the film was exfoliated in pieces, because of the oxidation of steel substrate [1]. In order to improve the stability in air, it seemed imperative to eliminate pinholes of the film, through which oxygen penetrates to the substrate from air. This study aims at densifying the ceramic film by optimizing the content of alkali silicates.

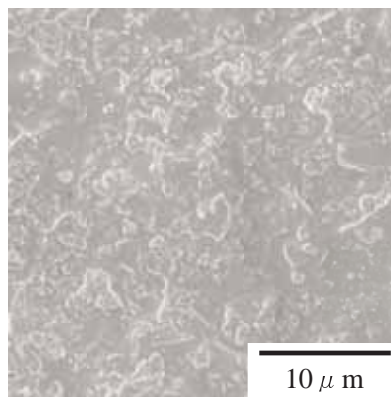
The coating slurry was prepared by mixing designated amounts of cristobalite, titania, alumina, kaolinite, sodium carbonate, sodium silicate, and potassium silicate in water. The total contents of sodium and potassium silicates was set to 26, 33 or 40 wt.%. The substrates used were steel plates (JIS-G-3141), which were blasted with alumina grains of 0.1 mm in diameter for surface roughening. The coating slurry, kept under continuous agitation by stirring, was applied on the steel plates with a doctor blade or a brush at room temperature, to a thickness of about 100 μm after calcination. The coated plates were dried overnight at 120 $^\circ\text{C}$, precalcined at 420 $^\circ\text{C}$ for 30 min, and calcined at a selected temperature up to 900 $^\circ\text{C}$ for 30 min in air atmosphere. The coatings were inspected on a scanning electron microscope (SEM). Adhesion strength was measured by using an adhesion tester.

Figure 1 shows SEM image of the ceramic coatings (precalcined at 420 $^\circ\text{C}$) different in the alkali silicates content. The silicates content affected the morphology of coatings drastically. With 26 wt.% silicates (a) ceramic grains with various sizes aggregated rather porously.

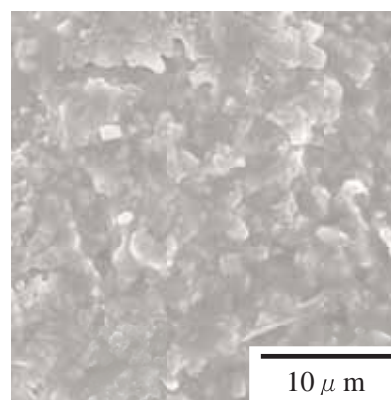
With 33 (b) or 40 wt.% (c) of alkali silicates, on the other hand, ceramic grains were packed more densely with no holes visible. It is considered that the glass phase resulting from the alkali silicates effectively fills pores among ceramic grains, leading to the densification. In fact, corrosion test in 1 mol/l HCl solution revealed that the number of through-holes of the coating decreased drastically with increasing alkali silicates content from 26 to 33 or 40 wt.%. The coatings were now stable to heating at 800 $^\circ\text{C}$ in air. The adhesive strength was also found to increase by three times with the silicates content



(a) Sodium silicate + Potassium silicate 26 wt.%



(b) Sodium silicate + Potassium silicate 33 wt.%



(c) Sodium silicate + Potassium silicate 40 wt.%

Fig. 1 SEM images of ceramic coatings calcined at 420 $^\circ\text{C}$.

Reference

[1] Y. Muroya, A. Motoki, G. Sakae, K. Shimanoe, T. Maeda, Y. Haruta, Y. Teraoka, N. Yamazoe, the Electrochem. Soc. Proceedings Volume 2003-16, p. 443, (2003)