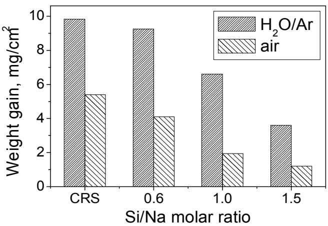
Nanostructured silicate coatings for prevention of high-temperature corrosion of cold rolled steel

L. Davydenko, D. Nasiedkin, M. Nazarchuk, Yu. Plyuto

Chuiko Institute of Surface Chemistry of the National Academy of Sciences of Ukraine, General Naumov Str. 17, Kiev 03164, Ukraine
E-mail: l.davydenko@yahoo.com

The oxy-fuel combustion process is currently considered as promising technology to attain efficient and clean coal utilization on power plants. As high temperature causes the high oxidation rate of metallic materials, the development of advanced coating capable to resist the chemical attack of oxy-fuel and steam environment and to supply high anticorrosion protection of the power plant components is of standing interest.

The goal of the present work was to develop the thermally and chemically stable nanostructured silicate coatings with increased Si/Na molar ratio and to evaluate their protective performance on cold rolled steel (CRS). The structure and anticorrosion protection of the coatings with Si/Na molar of ratio of 0.6-1.5 were studied at 650 ºC in air and water vapour.



Weight gain of bare and coated CRS samples after oxidation for 10 h at 650 ºC in 47% H_2O - 53% Ar and air

The coatings with Si/Na molar ratio of 0.6 are composed of polysilicate islands, chains and lamellas whose presence was confirmed by the intense band within 990-1100 cm^{-1} in IR spectrum. When Si/Na ratio reaches 1.0, the formation of stable sodium containing hydrosilicate monomers predominate and therefore the band at 850-920 cm^{-1} is observed. The high silica loading in the coating with Si/Na molar ratio of 1.5 favours the formation of three-dimensional polysilicate structure for which the intense band with maximum at 1235 cm^{-1} is characteristic.

The anticorrosion properties of the developed coatings were found to be dependent on their structural characteristics. The presence of three-dimensional polysilicate structures in the developed coatings ensures the high anticorrosion protection and leads to reduction of CRS oxidation by 75 and 60 % in air and water vapour at 650 °C, respectively.

Acknowledgement. The work is supported by the European Union in the frame of FP7 Collaborative Project NMP3-SL-2012-310436 “Production of Coatings for New Efficient and Clean Coal Power Plant Materials” (POEMA).