Coatings for Use at High Temperatures
Room On Demand - Session A3

Materials and Coatings for Solar Power Concentration Plants

A3-1 Biodegradable Polyurethane Antifouling Coating, ***Mohammad Mizanur Rahman (mohammadmizanur@gmail.com)***, King Fahd University of Petroleum and Minerals, Saudi Arabia

Controlled biocide leaching is one of the vital criteria's to consider any polymer as an antifouling coating. Besides the pollution of marine environments using excess toxic biocides is a huge concern worldwide. Almost all of the current commercial antifouling coatings contain toxic biocide. Thus, it is important to use a coating, which can control biocide leaching. Biopolymer can be a good choice in this regard as the biodegradable coating can be degraded easily with proper environment. Unfortunately little research has been done in this respect. Most of the research has been done mainly polycaprolactone based polyol. Xanthangum (Xn) might be a good choice. In this study biopolymer xanthan-poly(N-vinyl imidazole) (Xn-VI)was synthesized. The polymer was used in polyurethane (PU) coating to make a water erodible coating to improve the antifouling properties. Coating hydrophilicity, adhesive strength and erosionall varied with the Xn-VI contents. A good antifouling property for longer time was found in the PU-Xn-VI coating using biocide in the field test.

A3-2 Aluminide Coating for Inconel 625 Prepared by Additive Manufacturing: Investigation of the Surface Reactivity of the Substrate, *N. Ramenatte, L. Portebois, S. Mathieu, L. Aranda,* ***Michel Vilasi (michel.vilasi@univ-lorraine.fr)***, University of Lorraine, France

The project FAIR intends to develop innovative microreactor-exchanger (MR-E) based on 3D printing manufacture in order to intensify the H2 synthesis process. The Ni-based Inco 625 was selected as substrate due to its satisfying high temperature properties. Notably, it can resist against Metal Dusting corrosion provided it is protected by an aluminum reach overlay. The present study made it possible to characterize the coating processes as well as the oxidation behavior of the as-obtained coated substrate in connection with the physicochemical properties of 3D printed alloys (SLM) and in comparison with the conventional melted alloys (CMA).

A. Synthesis of Inco 625 via SLM

This process was conducting using the following main (non-confidential) parameters: alloy powder with a 10µm diameter grain size, melting under Ar atmosphere (P=1bar) and cooling at 10^7 K/s.

The as-obtained substrates are constituted of supersaturated γ grain having the nominal composition of Inco 625 and a textured microstructure showing a grain elongation parallel to the direction of growth.

As expected, the superficial roughness is huge due to the occurrence of fine spherical particles just sealed on the surface.

The wanted mechanical properties are then recovered by applying a heat treatment performed in the conventional conditions.

B. Coating depositions by CVD and slurry processes

Aluminum surface enrichments were performed using two techniques: i) the pack-cementation as CVD technique which is well known and described in the literature and ii) the slurry process also widely implemented for pieces having complex geometry, such as pieces comprising internal small channels. For both techniques, the rate limiting step is the solid state diffusion of metallic elements.

The coating elaborations were carried out on crude SLM and CMA substrates by applying a two steps heat treatment:

- the first one allows the aluminum enrichments through an annealing i) at 640°C during 4h for the packcementation process and ii) at 640°C and then at 700°C during respectively 4h and 1h, for the slurry process.

- The second step allows the NiAl formation by interdiffusion of metallic species which was activated by a high temperature treatment at 980°C during 1h.

Whatever the process, after the first stage of heating treatment, the same coatings were obtained: they are 40 µm thick and are two-phased systems comprising Al3Ni and Al3Ni2. This situation is the consequence of the similar interdiffusion coefficient of metals in SLM and CMA. Moreover, the present experiments evidence obviously that the rate limiting step is effectively the solid state diffusion for both synthesis techniques

A3-3 High-Temperature Protective Coatings against Molten Nitrate Salts for CSP Technology, ***Gustavo García Martín (gustavo.garcia@rep-energysolutions.com)***, REP-Energy Solutions, Spain; *V. Encinas Sánchez, M. Lasanta Carrasco, T. De Miguel Gamo, F. Pérez Trujillo,* Universidad Complutense de Madrid, Spain

The high demand for energy and its production through the burning of fossil fuel is one of the factors responsible for the impact of climate change on the Planet. This has revealed the need to develop and optimize renewable technologies.

Commercial concentrated solar power plants along with thermal energy storage systems, such as "parabolic trough", are more attractive than other renewable energies because of their thermal storage capacity, and are used when the resource (sun) is not available

Molten nitrate salts are currently considered ideal candidates for heat transfer and storage applications because of their properties. However, these salts are known for their high corrosiveness, increasing the associated O&M costs and making this technology still expensive compared to other renewable sources. This situation leads to propose solutions for reducing costs in terms of materials for the thermal storage systems (tanks, pipes, valves and heat-exchangers). One of these solutions is the development of high-temperature corrosion-resistant coatings, since they would avoid using expensive alloys (such as Ni-based alloys). The use of high-temperature protective coatings would be a very suitable option for reducing costs in CSP technology, even more if they enable the widespread use of low-cost steels, such as ferritic-martensitic ones. Thus, this solution would allow not only overcoming the corrosion problems, but also reducing the Levelized Cost of Energy, which would have a significant impact on the CSP technology. In this respect, ZrO_2-based sol-gel coatings appear as suitable option both from a technological and economical point of view.

Thus, in this work, sol-gel zirconia-based coatings were deposited on ferritic-martensitic steels and tested in contact with Solar Salt at 500°C, results being compared with the uncoated substrate. Results were also compared to other steels of interest in CSP industry, such as austenitic stainless steels. The study was developed up to 2000 h under static conditions. Samples were characterized via gravimetric, SEM-EDX, and XRD.

Results showed the good behavior of the coated substrates, with very little weight variations after 2000 h of test in comparison with the uncoated ones, which exhibited significant weight gain and spallation. The good behavior of the proposed coatings was also observed by SEM-EDX and XRD, showing a protective diffusion layer of about 5 mm. Furthermore, results also showed the promising behavior when comparing with steels currently used in CSP industry.

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