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Editorial

Coatings under Severe Conditions

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Coatings have historically been developed to provide protection against corrosion and erosion, that is, chemical and physical interaction of a material with its environment. Corrosion is a ubiquitous problem that continues to be of great relevance in a wide range of industrial applications and products; it results in the degradation and eventual failure of components and systems both in the processing and manufacturing industries and in the service life of many components.

Corrosion problems are faced in the process industries such as primary materials production, chemical, petrochemical, and power generation where they affect the efficiency of production (downtime, achievable process rates), product purity (contamination), energy consumption, and maintenance costs. They are also a major limiting factor in the life expectancy of components used in transportation, industrial production, and infrastructure: The direct cost of corrosion in the U.S. and European Union has been estimated at 3-5% of the Gross Domestic Product of the member states (Ref 1).

Some of the corrosion damage can be prevented by using already well-established knowledge, namely, choosing the appropriate corrosion protection and making the correct choice of materials. However, there is still much room for the development of materials and cost-effective surface coatings that can resist corrosion under specific conditions.

In addition, the search for reliable coatings that improve the performance of structural materials and extend the operating range of applications has accelerated because of the societal worldwide concerns for reducing energy consumption, conserving resources, and minimizing the emission of the products of corrosion to the environment.

At present, two important challenges faced by both developed and developing countries are the generation of energy and the sustainable management of the ever-increasing volume of waste. Indeed, the world's demand for energy is projected to double by Year 2050 in response to population growth and the industrialization of developing countries (Ref 2). The energy industry should seek more efficient and cleaner electricity and energy sources for motor vehicles, homes, and factories and more diversified energy resources to comply with environmental regulations and address greenhouse gas emissions and climate change.

One of the most ambitious projects for carbon-free energy production is nuclear fusion, and it is the subject of extensive internationally coordinated research. Yet it is almost certain that it will not supply a significant fraction of the world's energy before Year 2050. Other energy sources that could potentially make a substantial contribution to the world energy supply involve biomass, solar, wind, "decarbonized" fossil fuels and solid wastes. Globally, there are more than 600 waste-to-energy power plants that make it possible to drastically reduce the volume of waste and generate electricity and thermal energy for industrial use and district heating.

A key factor for the waste-to-energy systems is the proper choice of the materials used in their operation as they involve high temperatures, highly corrosive and erosive environments, and for the nuclear energy plants intense neutron radiation and high pressures. Therefore, there is a great need for coatings with the requisite strength and heat and corrosion resistance for long-term, reliable service, especially since the rates and efficiencies of many energy processes increase with higher temperatures.

Such coatings rely on the tailoring of innovative architectures at the nanoscale, development of specific coating materials hand-in-hand with that of substrate materials, adapted fabrication methods, and broad understanding of the relationships between process and product performance. Thermal spray processes that have the ability to coat a great diversity of components with a wide composition range of materials and also a large base of installed equipment can play a very important role in helping to meet these technical requirements in a cost-effective manner.

This special issue of the *Journal of Thermal Spray Technology* brings together papers that deal with coatings used under severe conditions. Key areas of concern are coatings for nuclear fusion plants, waste-to-energy power plants, steam generators and turbines, hydrometallurgical process (high-pressure acid leach), and hot-forming process of glass sheet.

This issue also features three review papers that are valuable reference sources to JTST readers in developing "Processing Strategies for Tailoring Ceramic-Based Nanostructured Thermal Spray Coatings," learning of the

potential for "Thermal Spray Coatings for Fusion Applications," and better understanding the "Nonlinear Behavior in Compression and Tension of Thermally Sprayed Ceramic Coatings."

References

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