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Editorial on Fundamentals of High-Temperature Corrosion and Protection of Materials

Daniel Monceau¹ · Jérôme Favergeon² · Bruce Pint³ · Clara Desgranges⁴ · Laurence Latu-Romain⁵ · Stéphane Mathieu⁶ · Fernando Pedraza⁷

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The study of high-temperature oxidation and corrosion is increasingly diversified due to its numerous applications. The following papers focus on the fundamental aspects associated with the durability of nickel-based superalloys, CrSi alloys, and titanium alloys for aeronautics, the durability of metals and oxides in current and future nuclear reactors, and the use of oxidation as a fabrication means to develop an oxide as a functional element in interconnects used in solid oxide fuel cell devices.

✉ Daniel Monceau
daniel.monceau@toulouse-inp.fr

Jérôme Favergeon
jerome.favergeon@utc.fr

Bruce Pint
pintba@ornl.gov

Clara Desgranges
clara.desgranges@cea.fr

Laurence Latu-Romain
Laurence.latu-romain@univ-grenoble-alpes.fr

Stéphane Mathieu
stephane.mathieu@univ-lorraine.fr

Fernando Pedraza
fernando.pedraza@univ-lr.fr

¹ CNRS, CIRIMAT/Université de Toulouse, Toulouse, France

² Université de Technologie de Compiègne, Roberval (Mechanics Energy and Electricity), Compiègne, France

³ Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA

⁴ CEA, Université Paris-Saclay, Gif-sur-Yvette, France

⁵ SIMaP, Université Grenoble Alpes, Grenoble, France

⁶ Université de Lorraine, CNRS, IJL, Nancy, France

⁷ La Rochelle Université, LaSIE, La Rochelle, France

These material/environment systems are often complex. Nonetheless, these studies are founded on a common scientific base at the intersection of physical metallurgy, thermodynamics, and chemical kinetics, with the mechanical properties of materials sometimes playing a significant role. It is essential to test this base, apply it to new cases, and develop it further when gaps in the theory are identified. The thermodynamic modeling of complex systems, such as predicting the thermodynamic behavior of fission products encountered between the (U,Pu)O₂ fuel pellet and the cladding in nuclear reactors, is progressing thanks to the development of databases and tools based on the CALPHAD (Computer Coupling of Phase Diagrams and Thermochemistry) approach. This approach also allows for considering the chemical potential gradients of species transporting within complex systems. However, we are still far from predicting the microstructure and composition of any reaction product. Also, many coupling mechanisms remain to be identified, for example, between oxidizing species (such as N and O in titanium alloys in one of the following papers) or between various types of interactions in model or complex systems. Finally, there exists an almost infinite number of new systems and material assemblies to study, as well as many little-known systems, such as the oxidation of PuGa alloys or thermal barriers based on high-entropy complex oxide solutions. The following papers stem from presentations at the 11th International Conference on High-Temperature Corrosion and Protection of Materials (HTCPM 2024), held at Les Embiez Island, France, on June 9–14, 2024.

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