INTERFACIAL PHENOMENA IN MOLTEN METALS-REFRACTORY BORIDES SYSTEMS

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ABSTRACT

Non-oxide ceramics, such as carbides, nitrides and borides represent one of the fastest growing classes of new advanced materials. Among them, transition metals ceramic diborides, in particular Titanium, Zirconium and Hafnium diborides, are members of a family of materials with extremely high melting temperatures, high thermal and electrical conductivity, excellent thermal shock resistance, high hardness and chemical inertness. These materials -Ultra High Temperature Ceramics (UHTCs)- constitute a class of promising materials for use in high performance applications, where high temperatures, high thermal fluxes, severe surface stresses are involved.
However, the possibility to exploit commercially their peculiar characteristics often depends to a great extent on the ability to join the ceramic parts one to the other or to special metallic alloys. As the behaviour of a metal-ceramic joint is ruled by the chemical and the physical properties of the interface, the knowledge of wettability, interfacial tensions and interfacial reactions is mandatory to understand what happens at the liquid metal-ceramic interface during joining processes.
Provided that a large number of ceramic materials are not wet (or poorly wet) by pure liquid metals, their wettability by liquid-metal systems can be significantly modified by using either non-reactive metallic solutes capable of adsorption at the metal-ceramic interface, or reactive elements, so that the energetic contribution coming from reaction (and dissolution) free energy release could contribute to lower the total interfacial energy of the solid-liquid system, increasing, at the same time, and thermodynamic adhesion.
Recent data on the wettability and the interfacial characteristics of different metal-ceramic systems, and in particular of (Ti,Zr,Hf)B_2 in contact with liquid Ag and its alloys (Cu, Ti, Zr, Hf) will be reported and discussed as a function of time, compositions and structure of the ceramic and of the alloy involved. In particular new data will be shown about the interactions of Ag, Cu and Au in contact with ZrB_2. Models will also be used to interpret the wetting behaviour and the adsorption/reaction interfacial phenomena involved.