Oxidation Above 3300°C of Refractory Materials in an Aluminized Flame

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High melting point and oxidation resistance are twin requirements to withstand a flame containing molten alumina at a temperature above 3300°C. The highest melting point materials are tantalum carbide (3985°C) and hafnium carbide (3928°C), but these oxidize to form non-protective molten oxides under typical oxidizing conditions in air. The two phase flow of molten alumina and gases changes the oxidation mechanism. The oxygen for oxidation is supplied by dissociation of a molten alumina film that is formed on deposition surfaces and continually renewed by flow separation. Calculation of the reaction initiation temperature (RIT) was performed by extrapolation of the free energies of formation of the reactants to the appropriate temperatures. Due regard was paid to known and potential phase changes. However, errors in these calculations tend to be similar for all systems so that a correct ranking of corrosion resistance with the RIT would be expected. The value of the RIT was found to correlate inversely with the degree of the attack for HfC, HfC.TaC, TaC, Ta_2C and tungsten. The plot shows tantalum carbide (RIT 3235°C) erodes at 2.3 x 10^{-3} cms/sec whereas graphite (RIT 2240°C) corrodes in excess of 25 x 10^{-3} cms/sec. Tungsten is not oxidized by molten alumina but suffers cavitation. This is believed to be caused by collapse of small clouds of alumina vapor that condense at 3980°C at this pressure.