

PLASMA PROCESSING OF OXIDE SYSTEMS IN THE  
TEMPERATURE RANGE 1000-3000 K

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The use of plasma reactors on the industrial scale for the processing of oxide systems will have as typical objectives the spheroidization or separation of simple and complex oxides, or alternatively the reduction of oxides to metals and alloys with a reductant such as carbon or hydrogen.

In either type of process it is envisaged that the solid to be processed will pass through a preheating and main processing (plasma) zone before being collected as a product or mixture of products in the final zone where the product may be solid or liquid material(s).

The maximum temperature which the reactant(s) can reach in passage through the reactor is a function of the time of residence in the three zones the optimum probably but not necessarily being in the plasma zone. In order to achieve temperatures in the range of 2000-3000 K with oxide materials it is necessary to use fine particles to match a short residence time, and hence the state of motion of the gas phase in the reactor which determines the trajectory of the particles through the reactor must be controlled appropriately. Examples will be given of temperatures achieved by oxide particles in an extended arc flash reactor, in which there is good opportunity for preheating particles before they enter the plasma zone, as a function of particle size.

The descent of oxide particles through a plasma zone leads to vaporization of some oxides and the thermodynamics and kinetics of this process are well understood for most oxide systems. The formation of volatile oxide species can encourage chemical reactions in high temperature systems, and reduction reactions may be carried on through the formation of metallic carbides as intermediate phases when carbon is being used as a reductant. In a number of reduction reactions in which the oxide to be reduced is very stable and relatively involatile, the reduction of particles via gas phase reactions involving the Boudouard reaction is improbable, or, even if probable, will only provide a small reduction capacity for the reaction during

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the relatively brief transit time of the plasma zone. It is therefore necessary to consider reactions involving the condensed phase products which emerge from the plasma in the overall design of a reduction system. Examples such as the production of ferrochromium will be considered of this aspect of plasma processing.

Finally, the need to consider the reversal of high temperature reactions in the lower temperature collection zone suggests that processes which are favoured as the temperature decreases should also be considered when contemplating a plasma reactor application.