"INTERNAL GETTERING" – METALLOTHERMIC REDUCTION PROCESSES IN THE EARLY STAGE OF SINTERING

Christian Gierl-Mayer and Herbert Danninger

Technische Universität Wien
A-1040 Vienna, Austria

Raquel de Oro Calderon and Eduard Hryha

Chalmers University of Technology
SE-412 96 Gothenburg; Sweden

ABSTRACT

One of the aspects of modern material systems for high strength sintered steel parts is the presence of alloy elements with widely different oxygen affinity. Compared to the base iron, the "new" alloy elements Cr, Mn and Si form oxides with much higher stability. It is shown here that in case of powder mixes this leads to oxygen transfer from the base iron particles to the alloy elements during heating up to sintering temperature, i.e. metallothermic reduction of the iron surfaces. With prealloyed powders, the surface oxides, which are originally mostly iron oxide, are transformed into alloy element oxides during heating unless the iron oxides can be reduced at low temperature with H_2. In any case, the heterogeneity of the oxygen affinity is a parameter that has to be considered when defining alloy systems for sintered steels.

INTRODUCTION

The reduction process of the powder particles is one of the key factors for successful sintering of PM steel products. Many studies show that in principle there are three stages of deoxidation of plain iron powders [1]. The first stage is mostly correlated to removal of adsorbed gases and physically and chemically adsorbed water on the surface of the powder, usually not hard to remove. Even after a dewaxing process at rather low temperatures the adsorbed species cannot be found anymore. The second stage is related to the removal of surface oxides, which is the crucial process for sintering. It is very important to notice that the heating stage is extremely important for the final properties of the material. Here it must be mentioned that different atmospheres result in different behaviour of the powders. As an example: In inert atmospheres the added carbon is needed as reducing agent, and the reduction via the reaction $FeO + C \rightarrow Fe + CO$ leads to a sharp peak of mass 28 (CO) in the analysis of the sintering atmosphere near 700°C. When the sintering is performed in hydrogen, the reduction process occurs at much lower temperatures by hydrogen forming water vapour, which can be detected as mass 18 (H_2O) at around 420°C, with only a little