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LOW TEMPERATURE OXIDATION OF IRON BORIDES

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Abstract: The oxidation of pure iron borides was investigated by X-ray diffraction, surface Mössbauer spectroscopy, scanning electron microscopy and thermogravimetry. Iron borides undergo oxidation at low temperature, with formation of both oxides and oxygen-free products.

1. Introduction

The oxidation of iron borides generally has been investigated using coatings grown on iron and its alloys. Polyphase coatings on iron base substrates, however, are systems very far from equilibrium and the effects of oxidation can be masked by other thermally activated modifications.

The aim of the present work was to study the early stages of oxidation of iron borides. Single phase specimens were prepared by compacting powders in order to avoid the phenomena connected with the participation of the metal substrate in the process.

2. Experimental

Powders of 99% pure Fe_2B and FeB were cold compacted and then oxidized in the 300°-450°C range, for 1 h, in pure oxygen. The oxidized samples were studied by means of X-ray diffraction (using a computer-controlled goniometer and CoKα radiation),

surface Mössbauer spectroscopy and scanning electron microscopy (carried out on both oxidized and fractured samples).

The Mössbauer measurements were performed by detecting the K X-rays (CXMS) and the K-shell conversion electrons resonantly re-emitted by the ^{57}Fe atoms (D-CEMS). The depth selective spectra were recorded by simultaneously detecting conversion electrons emerging at the surface with energies in ranges lying between 5.5-7.3 keV. The source was a 100 mCi $^{57}Co(Rh)$, and the spectra were computer-fitted to a series of Lorentzian peaks.

Thermogravimetric analyses were carried out on powder samples treated in the same temperature range.

3. Results

The oxidation of iron borides Fe_2B and FeB begins at temperatures much lower than those generally considered in the literature. This is an important factor to consider for practical applications in oxidizing environments.

The starting temperature of oxidation is lower for FeB ($\sim$300 °C) than for Fe_2B ($\sim$400°C). Oxygen easily reacts with boron giving rise to B_2O_3 and liberating iron. In the case of Fe_2B, iron reacts with oxygen giving rise to Fe_2O_3, while in the case of FeB iron preferentially reacts with the FeB itself giving rise to Fe_2B.

The probability of interaction between O and Fe in the boride lattices is low in the temperature range investigated. In the case of FeB, this interaction can explain the formation of appreciable amounts of FeB_x with x slightly greater than one.