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High-Temperature Ordered Intermetallic Alloys IX

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High-Temperature Ordered Intermetallic Alloys IX

Symposium held November 27–29, 2000, Boston, Massachusetts, U.S.A.

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PREFACE

High-temperature structural intermetallics continue to be an active field of research. These proceedings document the research presented at Symposium N, "High-Temperature Ordered Intermetallic Alloys IX," held November 27–29 at the 2000 MRS Fall Meeting in Boston, Massachusetts. The invited and contributed papers in these proceedings provide a representative cross-section of the world-wide research currently carried out on this topic.

The most "popular" material continues to be γ-TiAl which is beginning to find applications as a light-weight, high-strength, oxidation resistant structural material. Aluminides with $L1_2$ and B2 structures, which, in a way, started the field of intermetallics some 20 years ago, attract less interest than they used to. On the other hand, there is renewed interest in structural silicides with melting points on the order of 2000°C. Intermetallics with "functional" properties (i.e., properties other than mechanical properties) also started to receive some interest in this symposium. Examples include intermetallics with thermoelectric properties as well as intermetallics with shape memory effects at unusually high temperatures above 1000°C. The research described in this symposium covers a large spectrum of research ranging from very basic studies to actual applications and is therefore expected to be of interest for a wide range of readers.

Joachim H. Schneibel
Kevin J. Hemker
Ronald D. Noebe
Shuji Hanada
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Recent Advances in Development and Processing of Titanium Aluminide Alloys

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ABSTRACT

Intermetallic titanium aluminides are one of the few classes of emerging materials that have the potential to be used in demanding high-temperature structural applications whenever specific strength and stiffness are of major concern. However, in order to effectively replace the heavier nickel-base superalloys currently in use, titanium aluminides must combine a wide range of mechanical property capabilities. Advanced alloy designs are tailored for strength, toughness, creep resistance, and environmental stability. Some of these concerns are addressed in the present paper through specific comments on the physical metallurgy and technology of gamma TiAl-base alloys. Particular emphasis is placed on recent developments of TiAl alloys with enhanced high-temperature capability.

1. INTRODUCTION

Titanium aluminide alloys exhibit unique mechanical properties combined with low density and good oxidation and ignition resistance. Thus, they are one of the few classes of emerging materials that have the potential to be used in demanding structural applications at elevated temperatures and in hostile environments. A vast amount of efforts has been expended over the past ten years in attempts to optimize the composition and microstructure of the alloys [1-5]. Currently the alloy design is focused on γ(TiAl)-base alloys, which are slightly lean in Al and microalloyed with several third elements. These have led to complex alloys with the general composition (in at.%)

$$\text{Ti-(46-49)Al-(0-4)Cr,Mn,V-(0.5-2)Nb-(0-1)Si,B,C.} \qquad (1)$$

The major phases in alloys of this type are γ(TiAl) and α_2(Ti_3Al). In general, a reduction of Al content tends to increase the strength level, but is harmful for ductility and oxidation resistance. Additions of Cr, Mn and V up to levels of 2 % for each element have been shown to enhance ductility. The role of various other third elements is to improve other desired properties such as oxidation resistance (Nb, Ta) and creep strength (W, Mo, Si, C) [1]. Boron additions greater than 0.5 at.% are effective in refining the grain size and stabilizing the microstructure [6]. The addition of third elements not only changes the relative stability and transformation pathways of the phases, but also brings new phases into existence. It must be mentioned that the full details of the high-temperature phase equilibria and sequence of phase evolution with temperature and ternary or higher additions are not yet fully understood. By thermomechanical treatments a broad variety of microstructures can be generated in the alloys described by (1), which are often characterized in terms of the volume fraction of lamellar colonies and equiaxed γ grains; these are fully-lamellar, nearly-lamellar, duplex and near gamma structures. The general features of the correlations between alloy chemistry, microstructure and properties have been outlined in various review papers which should be consulted for additional background and