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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The mechanical and physical properties of Niobium Aluminide intermetallics for high temperature aerospace applications have been measured. NbAl sub 3 was induction melted. Metallographic and chemical analysis has been performed to confirm the composition and microstructure. The coefficient of thermal expansion was determined. Mechanical testing included elevated temperature elastic modulus and microhardness. Continuing work will focus on applying high temperature microhardness with varying load time to creep properties. Also, ingots of the two other intermetallic phases will be received shortly, with similar characterization to follow. Near-net shape processing may be used to form test specimens. A transmission electron microscopy effort will be used to identify deformation mechanisms.					
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Understanding the High Temperature Behavior
of Niobium Aluminides; First Year Summary Report

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by

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Title of Proposed Project: "Developing and Understanding the
High Temperature Behavior of
Niobium Aluminides and Niobium
Aluminide Composites"



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Department: Mechanical Engineering / Materials
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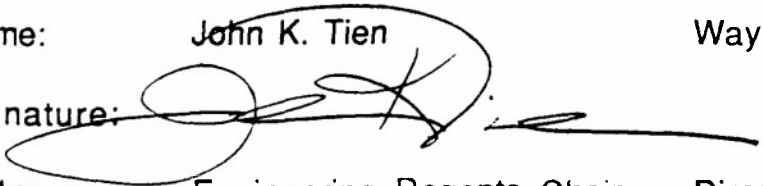
Proposed Start Date: December 1, 1990

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I. FIRST YEAR PROGRESS

First year efforts in this program have concentrated on the physical and mechanical characterization of the monolithic intermetallics. The first alloy of interest was NbAl_3 , the lowest melting of the three compounds. Since it is a line compound, this intermetallic was anticipated to be the most difficult to process. Four NbAl_3 ingots have been processed for us (gratis) by Nippon Mining Corporation by vacuum induction melted from a stock of niobium oxide and elemental aluminum. To counter aluminum volatilization, excess aluminum was added during processing. They were remelted in vacuum to a final weight averaging 200g. Nippon Mining Corporation is currently melting a fourth NbAl_3 ingot, as well as a Nb_3Al ingot.

All four as-received samples exhibited some microcracking and porosity. Initial characterization included spectrographic analysis and optical and scanning electron microscopy. Chemical analysis results are as follows:

Alloy A	65 at. % Al
Alloy B	80 at. % Al
Alloy C	79 at. % Al
Alloy D	79 at. % Al

All alloys exhibited a two phase microstructure. Alloy A contained NbAl_3 and NbAl_2 . Alloys B-D were shown to have a mixture of intermetallic and aluminum solid solution. A typical microstructure is shown in Figure 1.

Alloy A was analyzed by Differential Scanning Calorimetry, although initial results are inconclusive. The coefficient of thermal expansion of this alloy was determined and found to be $11.3 \times 10^{-6} / ^\circ\text{C}$. Initial mechanical characterization of Alloy A has included microhardness as a function of temperature and uniaxial compression testing at 871°C . The average elastic modulus in compression was found to be 1.23×10^6 psi.

The SMR&DL has recently purchased a state of the art elevated temperature microVickers hardness (microindentation) tester. Sample and indenter can be heated to 1600°C in vacuum or inert atmosphere. Load,

loading rate, and time on load can be varied independently. Indentations are measured using a 400x optical microscope to an accuracy of 5 microns. The hardness vs. temperature data for Alloy A is given as Figure 2.

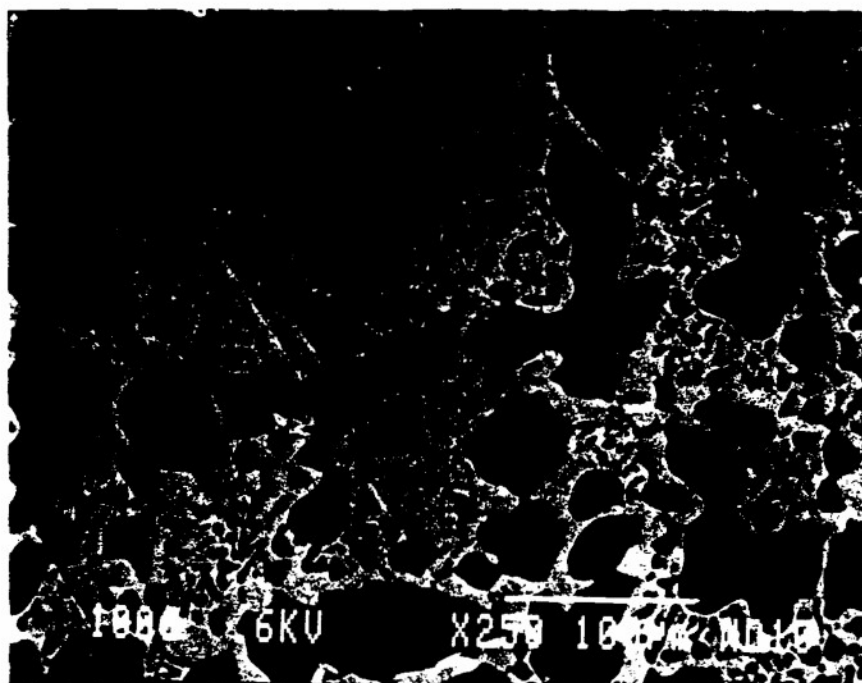
Currently, our primary effort is to use the full capabilities of our hardness tester to study the yield and time dependent deformation of this system. By varying the time on load, we have previously been successful in applying creep analyses to other intermetallic systems. We are in the process of applying a similar analysis to the NbAl_3 system. This method will give us insight into the deformation behavior at various temperatures. We hope to present and publish this and other data at the MRS annual meeting in Boston.

II. SECOND YEAR EFFORTS

In the coming year, we hope to have a detailed understanding of physical and mechanical properties of all three monolithic intermetallics. As previously mentioned, an initial heat of Nb_3Al is currently being processed, in addition to another ingot of NbAl_3 . If this 5th heat of NbAl_3 does not yield the stoichiometric composition, we hope to explore other methods of processing concurrently with the characterization of the other two intermetallics. We are considering two other methods. The first method is to make a NbAl_3 mother alloy (as-melted), make an alloy powder, and HIP (hot isostatic press) with the necessary chemistry corrections. The SMR&DL has also recently purchased a HIP unit with temperature and pressure capabilities of 2000°C and 35 ksi which would accomplish this task. Secondly, recent literature reviews have indicated that Plasma Arc Remelting has been successful in obtaining the correct chemistries.

Second year efforts will then begin on mechanical characterization of the Nb_2Al and Nb_3Al intermetallics. After initial uniaxial compression tests have been completed, select material will be tested in tension and creep. Since machining of these brittle compounds is difficult, we will also process these test specimens by HIPping to near net shape. Deformed samples will then be analyzed by TEM.

In parallel with the mechanical testing, an oxidation study will be continued. In addition to automated weight gain measurements, a detailed study of oxide morphology should clarify future directions for ternary additions.



Two-phase microstructure of Alloy A

FIGURE 1

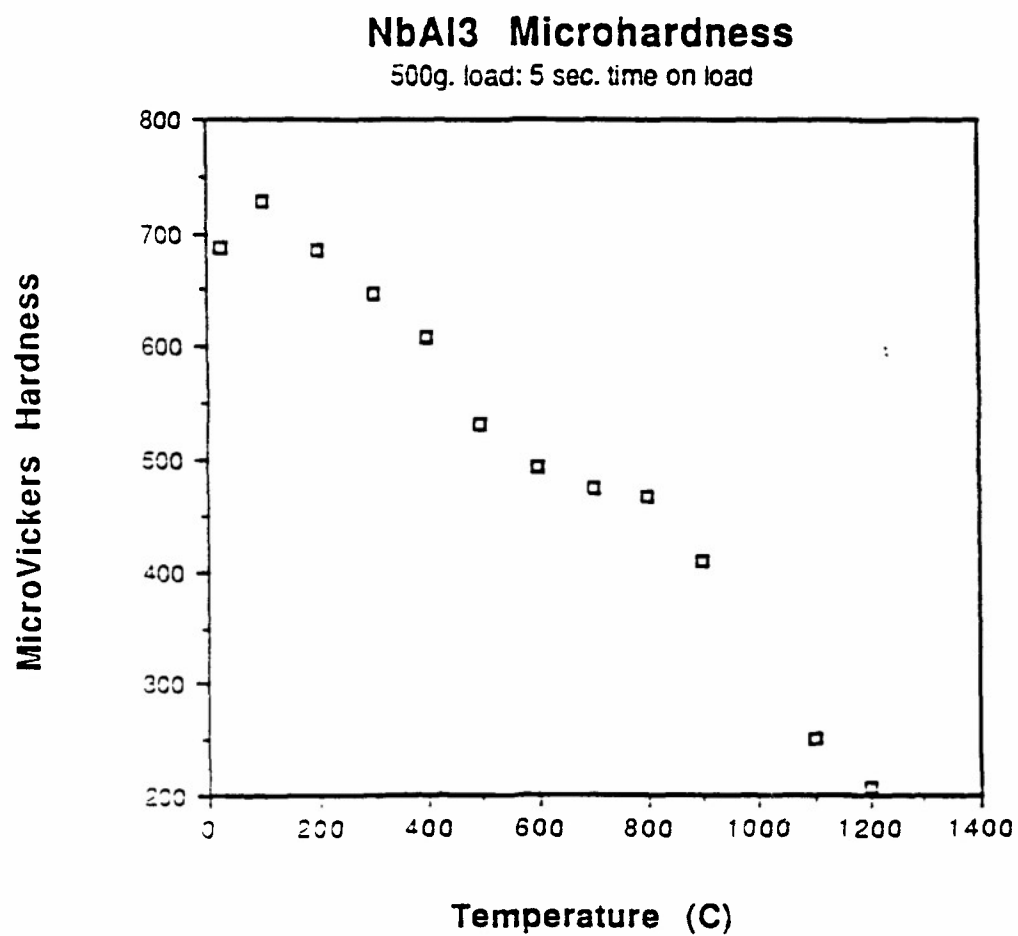


FIGURE 2