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Titanium Aluminide Foil Made from Plasma-Sprayed Preform—Extended Abstract*

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1. Introduction

High-strength titanium alloy (HSTA) and titanium aluminide foils are required for fabricating SiC fiber-reinforced composite structures and honeycombs for aerospace engines and structures. Conventionally, such foil materials would be made by cold rolling a continuous strip to foil gage. However, in case of HSTA (e.g., Ti-6Al-4V, Ti-6Al-2Sn-4Zr-2Mo, etc.) and titanium aluminide intermetallic materials, such continuous strips are not available. This is because unidirectional hot rolling of HSTA gives rise to an unfavorable texture. HSTA must be cross-rolled during hot rolling to sheet gage to balance the hot rolling texture. Therefore, HSTA is not available in strip form and can only be produced in the form of 2.44 m (8 ft) long sheets. Rolling such 8 ft long sheets to foil gage is inefficient and makes the foil product expensive, thereby discouraging commercial applications.

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2. The New Method for Foil Production

A new method for making continuous foil of HSTA and titanium aluminides has been developed that involves fabrication of plasma-sprayed preform and consolidation of such preforms to a 100% dense foil product. Trials to demonstrate the feasibility have been completed. The microstructure and mechanical properties of titanium aluminide foil (0.102 mm, or 0.004 in.) produced from plasma-sprayed Ti-6Al-4V preforms were identical to those of conventional ingot metallurgy foil.

Tables 1 and 2 show the chemical analyses of plasma-sprayed preform and consolidated foil of Ti-6Al-4V and Ti-14Al-21Nb alloys. Tables 3 and 4 show the mechanical properties of Ti-6Al-4V and Ti-14Al-21Nb alloy foils prepared by consolidating the plasma-sprayed preforms. The mechanical

Table 1 Chemical analysis of IM Ti-6Al-4V alloy foil, PS Ti-6Al-4V preform and foil

Element, wt%	Feedstock powder	PS preform	Consolidated PS foil	IM foil
Carbon	0.030	0.041	0.053	0.10
Hydrogen	0.0036	0.0124	0.0051	0.015
Nitrogen	0.0095	0.012	0.013	0.05
Oxygen	0.18	0.22	0.290	0.20
Aluminum	...	6.15	...	6
Vanadium	...	3.80	...	4

Table 2 Chemical analysis of IM and PS Ti-14Al-21Nb titanium aluminide foil

Element, wt%	PS preform	Consolidated PS foil	IM foil
Carbon	0.018	0.029	<0.02
Hydrogen	0.0072	0.0006	<0.001
Nitrogen	0.021	0.017	<0.008
Oxygen	0.161	0.178	<0.08
Iron	0.048	...	...
Aluminum	...	15.4	14.4
Niobium	...	20.4	22.1

Table 3 Tensile properties and bend ductility of PS and IM Ti-6Al-4V foil (a)

Sample	Gage, in.	Modulus, Msi	0.2% YS, ksi	UTS, ksi	Elongation, %	Hardness, HV	180° bend ductility(b)
PS foil	0.0043	15.6	133.7	136.2	7.8	325	2.0
IM foil	0.0043	14.5	118.1	126.4	16.5	325	3.3

(a) Subsize tensile specimens, 1.0 in. gage length, 0.25 in. gage width. (b) Room temperature

Table 4 Tensile properties and bend ductility of PS and IM (α_2) Ti-14Al-21Nb foil (a)

Sample	Gage, in.	Modulus, Msi	0.2% YS, ksi	UTS, ksi	Elongation, %	Hardness, HV	180° bend ductility(b)
PS foil	0.0043	9.7	78.9	83.9	5.9	250	3.0
IM foil	0.0043	9.2	51.0	71.3	8.8	230	8.0

(a) Subsize tensile specimens, 1.0 in. gage length, 0.25 in. gage width. (b) Room temperature properties of plasma-sprayed (PS) foil are compared with those of the conventional ingot metallurgy (IM) foil. The foils prepared from PS preform have higher yield strengths due to a higher oxygen content.

The plasma spray-roll consolidation route can be adapted for fabricating titanium aluminide foil as a continuous coil. This procedure will improve process efficiency and yield high-quality titanium aluminide foil at low cost.