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Acetylene Plasma Deposition on Gamma-TiAl Alloys

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Titanium aluminide alloys based on the intermetallic phases gamma-TiAl and alpha$_2$-Ti_3Al are widely recognized as having the potential to meet the requirements for moving structures. The intention of these applications is to substitute the heavier super alloys in certain of stress and temperature [1]. Gamma-TiAl alloys are good bulk properties, but are limited ductility and poor surface properties [2-5]. The alloys, Ti-47at%Al-2at%Nb-2at%Cr (MJ12) and Ti-47at%Al-2at%Nb-2at%Mn+0.8at%TiB_2 (MJ47), are provided by Howmet Corp., Whitehall, MI, U.S.A. Following similar plasma nitridation [6], the alloys were carburized using acetylene at - 3 kV bias voltage for 1-4 h. By using 1 gf load, Knoop microhardness (HK) was measured for 10 times. Average and standard deviation were calculated. The alloys were analyzed using XRD in combination with JCPDS software [7] and SEM equipped with EDX.

HK of MJ12 and MJ47 (Fig 1) is increased with the increase of deposition time. Hardness of untreated MJ12 and MJ47 is 234.9 19.6 kg.mm^{-2} and 289.8 66.0 kg.mm^{-2}, respectively. For 4 h deposition, HK of MJ12 and MJ47 is 1.88 and 1.57 times of the corresponding untreated alloys, respectively. During plasma deposition, acetylene decomposed into atoms and ions. Only positive ions were accelerated and attached on the alloy surfaces. The number of ions attached and embedded on the alloy surfaces are increased with the increase in the deposition time. By using XRD, phases of Al, AlTi, Al_2Ti, TiC and C (Fig 2) were detected due to the phase transformation of TiAl into Al_2Ti, TiC formation with Al release and C condensation. EDX analysis revealed the presence of Ti, Al and Nb on MJ12 and MJ47 (Fig 3). Additional Cr and Mn were detected on MJ12 and MJ47, respectively. B is very light element and was not detected on MJ47. After carburizing, C was detected as well. SEM micrographs (Fig 4) show morphologies of the alloy surfaces after deposition. Their surfaces were very rough. Particle size of the deposition products is less than 100 nm. They are arranged densely and have almost circular shape.

Acknowledgements

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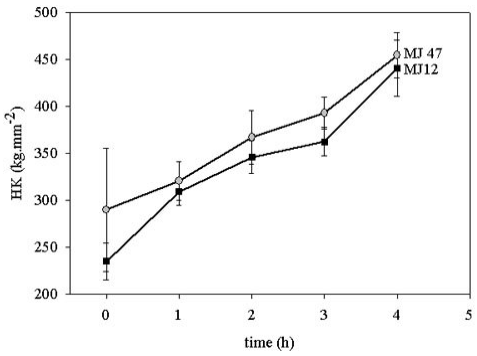

Fig 1. HK of MJ12 and MJ47 at - 3 kV bias voltage for 1, 2, 3 and 4 h (0 h = untreated alloys).

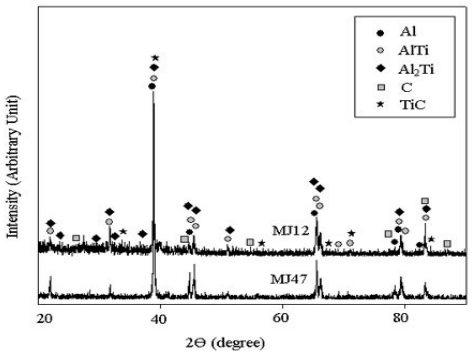

Fig 2. XRD of MJ12 and MJ47 at - 3 kV bias voltage for 4 h.

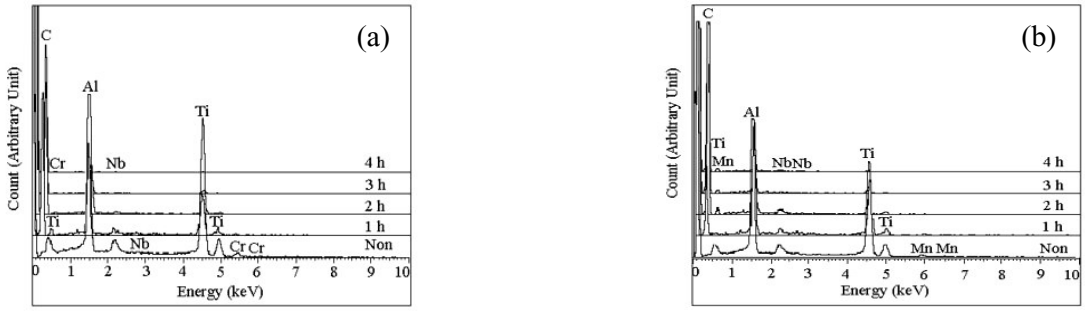

Fig 3. EDX of (a) MJ12 and (b) MJ47 with and without deposition at - 3 kV bias voltage for a variety of the prolonged times.

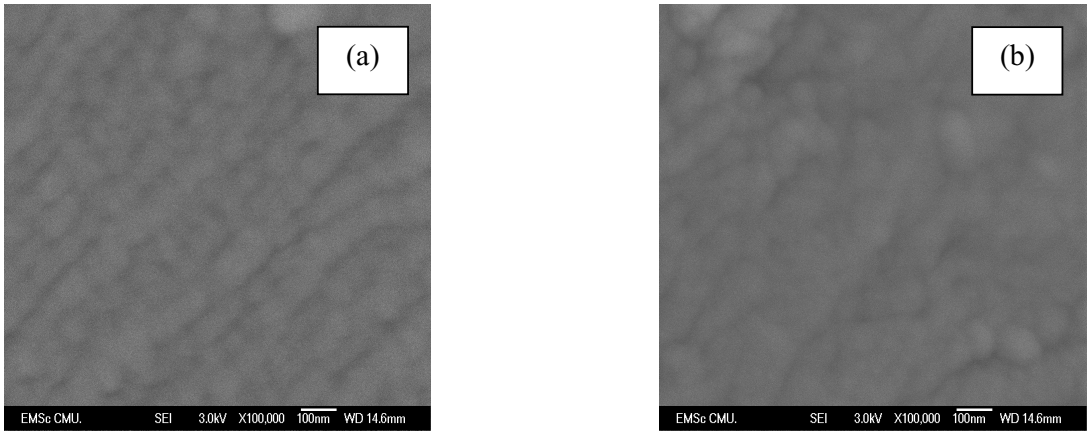

Fig 4. SEM of (a) MJ12 and (b) MJ47 deposited at - 3 kV bias voltage for 4 h.

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