CHAPTER 1

INTRODUCTION

The intermetallic compounds of TiAl, γ-TiAl based alloys, are highly interested in recent years. They are considered for use in aerospace applications in both structural components for aircraft, space satellites and missiles and jet engine components such as turbine blades, engine valves and turbocharger rotors owing to their high temperature strength, low density, high melting point and adequate creep resistance at high temperatures [1-9].

There are two major disadvantages for TiAl based alloys. They are very limited ductility at room temperature and poor surface properties at high temperature [5-8]. The former can be improved by the addition of some elements. The latter can be improved by surface modification. Many studies have reported that the addition of Nb, Cr, Mn, Mo, W, Ta or V is to improve fracture toughness, ductility and corrosion resistance of TiAl alloys [8,9]. Furthermore, the dispersion of hard boride particles in TiAl alloys such as TiB_2 or CrB can improve wear resistance.[5].

Titanium carbide (TiC), titanium nitride (TiN) and titanium carbonitride (TiCN) coatings have been widely applied to improve hardness, wear resistance and corrosion resistance for many applications such as cutting tools, dies, etc [6-7,11-15]. TiCN coating had lower friction coefficient and higher wear resistance than TiN. TiC coating tends to spall due to its high internal compressive stress. In case of TiCN coating, very little internal stress is present, leading to good coating-substrate adhesion [12-14].

Titanium aluminium nitride (TiAlN) coating was developed in the late 1980's [16]. TiAlN and TiAlCN (titanium aluminium carbonitride) films exhibit superior oxidation resistance comparing to TiC, TiN and TiCN films [16-19]. It is reported that TiAlCN film had higher hardness and better wear resistance than TiAlN film [19].

There are many processes to deposit these films on the alloy surfaces. They are magnetron sputtering [15,16], cathodic arc ion plating process [12-14], plasma enhanced chemical vapor diposition [17-19], plasma assisted deposition [5,20], plasma immersion ion implantation [21-23], thermo-reactive diffusion [24] and direct metal-gas reaction [6-7, 25]. Comparing with other processes, direct metal-gas reaction is less costly and has no toxic chemicals [6-7].

The purpose of present studies is to modify and characterize the surfaces of γ-TiAl alloys by new techniques. Nitridation and carburization by direct metal-gas reaction in ammonia and acetylene, the nitridation by direct metal-gas reaction in ammonia and the carburization by directly applying voltages across γ-TiAl alloys were performed. Formation of new phases, chemical composition, film thickness, mass increase, density increase, diffusion coefficient, Knoop hardness and wear resistance of the alloys are then investigated.