Chapter 8
Recent Advancements in Wear-Resistant Coatings Prepared by PVD Methods

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ABSTRACT

Physical vapor deposition (PVD) technologies are widely used to produce wear and corrosion resistant coatings for a variety of industrial applications. In recent years, there has been remarkable interest in the development of novel wear resistant coatings prepared through PVD methods, which helps to reduce friction and wear, as a result of recovering energy losses up to 30% due to friction and economy loss due to wear. This chapter provides comprehensive data of recent progress in wear resistant coatings prepared using PVD methods, starting with the introduction of it needs, significance, physiochemical properties, and the selection criteria of wear resistant coatings. The applications, physical, and chemical properties of superhard materials such as diamond like carbon (DLC), titanium nitride (TiN), chromium nitride (CrN), and tantalum nitride (TaN) are also presented.

DOI: 10.4018/978-1-7998-9683-8.ch008

INTRODUCTION - NEED FOR WEAR RESISTANT COATINGS

Wear is a material degradation process due to the continuous tribological interactions. Surface modification on alloys/metals are often applied to modify the surface properties, which are generally used in applications having aggressive environments, show explicit performance at their surfaces, such as excellent corrosion and wear resistance. Wear resistant coatings can be implemented, where the use of liquid lubricants (grease, oil, etc.) proves unsuccessful due to excessive load, migration, extreme temperature or neglected surfacing. The tribological, corrosion and mechanical properties of any alloy/metals can be enhanced by deposition of thin/thick hard coating onto the surface of a metal to elevate the overall component performance.

Generally organic (paints, polymers) and inorganic (electroplating, electrophoretic, conversion coatings, and galvanizing) based coatings are applied onto metals, but many of these types of coatings suffer from several glitches including limitations towards high temperature application or lack of wear resistance. When a unique combination of high temperature, wear, and corrosion resistance is needed, coating processes such as electroless plating and electroplating are used, but these coatings often face environmental problems associated with the coatings themselves. Often, it might be hard to find the perfect balance between corrosion and wear resistance among these. Transition metal carbides and nitrides based hard coatings are extensively used nowadays to protect the materials against corrosion and wear.

BACKGROUND

Every industrial production, mechanical tools are the key components. Therefore, it is inevitable to enhance the tool lifetime and productivity. In the last decade, ceramic and composite materials have also been implemented other than metals. Wear resistance is a common term and there are many types of wear, which are encountered such as abrasion, impact, fretting, and frictional sliding and so on. Surface coatings find usage in drills, cutters, taps and milling tools. Wear resistance coatings on interacting surfaces are important in industrial corrosion protection, which demands more innovative ideas. They are essential and requires scheduled maintenance to make sure good working condition. Excessive wear of components during the production resulting in immediate replacement of component or maintenance certainly occurs. This is a major cause of concern in terms of maintenance, depreciation, costs due to delay in production.

Lightweight alloys and metals have become essential components in automotive, transportation, aerospace, and many other industries. There is a huge demand for their wide range of applications, these lightweight metals and alloys have met a wide range of surface solutions. The feasibility of cost to weight ratio, they can contribute to improve the performance and efficiency in these industries. In spite of having improved weight-to-strength ratios, lightweight alloys show less hardness and have reduced resistance to wear.

One possible solution to address these stability related issues and also getting superior performance is to deposit wear resistant coatings onto the components that are prone to wear and damage. This outstanding wear resistance can be achieved through an optimum combination of fracture toughness and hardness of the coatings. Enhanced hardness protects the overlay coating from impact, cutting and fragmentation. In addition, ductility, increased toughness and compressive stresses of the coating reduce surface fatigue, micro cracking and failure.