Chapter 5
Recent Advances in Design and Fabrication of Wear Resistant Materials and Coatings:
Surface Modification Techniques

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ABSTRACT

In recent years, the demand of wear resistance material and coating is increasing very rapidly as it reduces substantial energy losses resulting from wear and friction. To overcome these energy losses, surface engineering is employed. Surface engineering is the process of coating or modifying the surface of part to minimize wear, friction, corrosion, as well as to enhance the lifespan of machine components and reduce the manufacturing cost. Recently, numerous coating methods are available for distinct material (pure metals to alloys, carbides, composites, and ceramics) applications. Hence, this chapter provides an overview on the prevention of tribo-surfaces through distinct methods of surface modification such as thermal, physical, and chemical methods of coating. Further, distinct coating properties, applications, future scope, and challenges are described.

INTRODUCTION

Tribology is the study of wear, friction, and the lubrication of interacting surfaces. Various techniques such as laser processing, mechanical processing, plasma processing, electro processing, chemical processing, thermal spraying, ion implantation, and gas nitriding are employed to enhance the resistance against the wear of components. However, coatings obtained by thermal spraying is gaining more in-

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terest. These coatings processes provide various benefits by combining versatility, cost effectiveness, and the ability to coat wide range of coating materials on different substrate. In addition, wide range of coating thickness (from tens to hundreds of microns) can be achieved on parts having complex geometry by using thermal sprayed processes (Joshi, 2019). Thermal spraying is a group of coating deposition techniques that includes flame spray (FS), high-velocity oxy or air-fuel spray (HVOF, HVAF), vacuum and atmospheric plasma spray (VPS, APS), electric arc spray also known as twin wire arc spray, wire or powder flame spray, detonation gun spray (D-Gun), high velocity oxygen liquid fuel (HVOLF), cold gas dynamic spray (CS), suspension and solution spraying etc. These coating deposition methods aim to enhance the desired surface performance/life by improving the distinct properties including tribological and mechanical properties. Then, these techniques are highly used for retaining superior mechanical properties, resistance against corrosion, resistance against wear, oxidation resistance, repair of machine parts, obtaining high thickness of the coating, retain bond strength with a greater coefficient of thermal expansion, It also exhibits electrical conductivity, low friction, sacrificial wear, insulation, lubricity, chemical resistance, and many other desirable surface properties (Garcia et al., 2018; Liu et al., 2019). The wide variety of non-metallic or metallic materials utilization which are extremely high melting point, recoat worn part without changing surface properties/size, enhance aesthetic properties etc. are main key merits of thermal spray processes (Joshi, 2019). Consequently, thermal spray technologies are commonly used in distinct industrial areas such as aeronautics and defense, paper production, power generation, automotive, marine and mining, electronics and semiconductor, steel and iron, textile, medical among others.

Despite that in the starting of the twenty century the Max Ulrich Schoop engineer write a patent that involves the thermal spray, thermal spraying process s development started in the decade of 1980s with the flame spray as the base of other techniques. In 1882 the Oerlikon published a first patient which consists of spraying lead powder against a fixed surface. Thereafter, in 1909 Max. Ulrich Schoop work on a patent called metal casting. In 1912 practical flame spray (wire gun) was introduced and in plasma spray coating method with hybrid feedstock was developed in 2019.Schoop's group also developed the electric arc spray technique using a metal with a low melting point as feedstock material for the coating deposition to protect metal surfaces from corrosion..During the same decade the 3rd family of TS techniques known as cold spray (solid-state) was introduced. that does not melt the feedstock material (Kumar et al.,2020(a); Kumar et al., 2020 (b); Kumar et al. (2020 (c)). Although, the temperature of the cold spray process is much lower than other thermal spray processes, which can effectively avoid phase transition, thermal cracking, oxidation, and other problems caused by the high temperature (**Figure 1**).