Chapter 10
Role of Alloying Elements on Powder Metallurgy Steels and Spectroscopic Applications on Them

Sefa Celik
Istanbul University, Turkey

Nuray Bekoz Ullen
https://orcid.org/0000-0003-2705-2559
Istanbul University-Cerrahpasa, Turkey

Sevim Akyuz
Istanbul Kultur University, Turkey

Aysen E. Ozel
Istanbul University, Turkey

ABSTRACT

The powder metallurgy (PM) technique is suitable for mass production and is a well-established process for the low production costs of net-shaped products close to long series. The properties of the iron-based PM parts, such as strength, hardness, magnetic properties, impact, wear, and corrosion resistance, can be improved with adding various alloying elements. The desired surface performance can be achieved with various surface coating technologies. Recently, various coating techniques have been developed as discussed in the chapter. The alloying elements have a significant effect on the coating quality of the final product. Surface coating can be analyzed by examining the surface-coated powder metallurgy (PM) using infrared and Raman spectroscopy technique. This contribution focuses on the role of alloying elements on properties and coating technologies of powder metallurgy steels and Fourier transform infrared (FT-IR) and Raman spectroscopic applications on them.

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1. THE IMPORTANCE OF POWDER METALLURGY IN INDUSTRY

Powder metallurgy (PM) process is a near-net-shape production process that combines the properties of shape-making technology for powder compression with the improving of ultimate material and design properties (mechanical and physical) along with the subsequent densification or consolidation processes (e.g., sintering).

PM methods produce complicated components in a simple process, gas atomization, due to rapid solidification, easily and safely allows microstructural modifications such as grain refinement, reduced segregation, and increased solubility. Low cost and high quality in mass production, wide alloying probability and low-density part production are other advantages of PM technology (Angelo and Subramanian, 2008; Chawla et al., 1999; Lee et al., 1998). Nowadays lots of PM-products are used in various industries; these are automotive and off-highway vehicle applications, machinery, computers and fabric sector equipment, home appliances and biomedical device manufacturing sectors. PM products have high surface quality and their properties such as strength and wear resistance may be improved by applying heat treatment. PM methods ensure part-to-part reproducibility and are appropriated to medium-to-high volume manufacturing. If required, controlled microporosity may be supplied for self-lubrication or filtration. The advantage of the method is that the PM alloy can be exactly designed for environmental agents. Then, it may be applied in low amount to form a metallurgical bond with a low-cost substrate that will withstand application conditions (Samal, 2015; Lee et al., 1998). The desired surface performance can be achieved with various surface engineering technologies that can be applied to PM components. In recent times, many numbers of surface coating techniques have been developed such as organic coatings, ceramic coatings, metallic coatings, laser-based techniques, thermal spray coatings, chemical vapour deposition (CVD), physical vapour deposition (PVD) coatings, and other methods of surface modification, which help to improve the tribological properties of the PM materials (Boing et al., 2020; El-Eskandarany, 2015; Donghai et al., 2017; Lee at al., 1998).

PM technology combines different fields, such as polymer and chemical engineering, physical metallurgy and surface sciences. Advances in the field of PM in the last decade are the result of a method of a multi-disciplinary approach (Narasimhan, 1996; Klar and Samal, 2007; Dangsheng, 2002). An extensive range of engineering materials are available, and through proper material and method selection, the necessary microstructure may be created in the material with the addition of variety alloying elements. Alloying additives such as nickel, copper, molybdenum, graphite or carbon are added to the base iron powder to provide the desired performance characteristic of a PM product. A few alloying techniques are available to create PM-products from low alloy powders (Samal and Newkirk, 2015; Salgado et al., 2001; Klar and Samal, 2007). In this chapter; alloying techniques of PM steel products and the effects of alloying elements on PM steel parts, and their surface treatment are discussed. In recent years, surface the coating technologies used in coating of PM-products have been mentioned. Moreover Fourier Transform Infrared (FT-IR) and Raman spectroscopic studies on the alloy composition of PM steels will be discussed.

2. ALLOYING METHODS IN POWDER METALLURGY

The microstructure of PM materials, the size, morphology and distribution of the pores in it, directly affect the mechanical properties of the product. Alloy elements are added to increase material performance

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