

Investigation of the Effect of V Particles Added to Steels Manufactured by Powder Metallurgy

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Abstract – Powder metallurgy (PM) production method is one of the widely used production methods. With the PM method, it has many features such as less material loss, easy production of complex parts, and secondary processing is generally not required. Stainless steels are the development of low-alloyed or unalloyed steels. Stainless steels are widely used in industry and biomaterial fields due to their advanced properties such as superior mechanical properties, resistance to corrosion, and use as a biomaterial. Graphite, iron, titanium, vanadium and tungsten carbide were used in this study. By PM method, 0.05 wt% and 0.1% V were added into graphite, iron and titanium powders. The powders were subjected to mechanical alloying process with a mechanical alloying device at 400 rpm for 30 minutes. Samples of each composition were formed by cold pressing the mixed powders with a one-way press device under 700 MPa pressure in the mold produced in ASTM –E8M standards. After pressing, it was sintered for two hours at 1250°C in an argon atmosphere gas environment. Production process, tensile test of finished samples, microstructure analyzes were done.

Keywords – Powder metallurgy, Sintering, V Particles, Microstructure, Manufacture

I. INTRODUCTION

Powder metallurgy is the process of producing materials by applying the compression process of powders of certain sizes in the mold under pressure, and then applying the sintering process below the melting temperature. The properties of the produced samples may vary depending on the powder size, pressing pressure, pressing technique and sintering temperature [1]. The materials produced by the PM method are better in terms of mechanical properties due to their more homogeneous structure [2]. Although the quality of the materials produced with PM is very good, it is also very good in terms of surface roughness, secondary processing is generally not needed [3]. The production of complex shaped parts with the PM method has features that other production methods do not have due to its advantages such as low material loss or no

material loss during production, mass production and low production cost [4]. In addition, the parts produced by the PM method are used in many areas in the automotive industry, electrical industry, military equipment parts, and health sector. PM production generally consists of powder production, powder mixing, pressing and sintering, respectively. Unalloyed steels cannot provide the desired properties in terms of formability, corrosion resistance and mechanical properties. For this reason, stainless steels containing alloying elements such as nickel, chromium and molybdenum are used instead of unalloyed steels. The mechanical properties, corrosion resistance, aesthetic appearance and ease of shaping of stainless steels have led to an increase in the usage areas day by day. The resistance of stainless steels against corrosion is provided by the chromium alloy. The chromium

alloy forms an oxide layer by clinging to the surface of the stainless steel, and thanks to this layer, it gains resistance to environments such as chloride and acid [5-7]. Apart from chromium, other alloying elements are added to improve the properties of stainless steels. Alloys such as nickel, molybdenum, vanadium are some of the alloying elements added. Steels contain carbon, silicon phosphorus and small amounts of aluminum elements. While these elements impart hardness to steels, elements such as nickel, vanadium, titanium and manganese give stainless steels the ability to be shaped. Stainless steels are widely used in industry and health fields due to their high corrosion resistance, resistance at variable temperatures, long life, being usable in terms of health and many advanced features [8-10]. In this study, the effect of adding Vanadium to steel at different weight % ratios on the microstructure was investigated.

II. MATERIALS AND METHOD

In this study, the production of Vanadium reinforced samples, which were added at certain ratios, was carried out using the PM method. The microstructural properties of the produced samples were examined by tensile testing.

The mixed powders were subjected to unidirectional cold pressing under 700 MPa pressure in a mold with 558ASTM E-8M standard. The pressed samples were sintered at 1250°C for 2 hours in an argon atmosphere gas environment, and the production of the samples was completed. Tensile test was applied to the sintered samples. XRD analyzes of the produced samples were made. For all samples, SEM images were taken at different magnifications from various areas and care was taken to ensure that these images were representative of the entire microstructure.

III. RESULTS AND DISCUSSION

Scanning electron microscopy analyzes of the samples produced by powder metallurgy method by supplementing Vanadium at different rates were performed (Figure 1). According to the results of this analysis, evaluations were made from the data obtained.

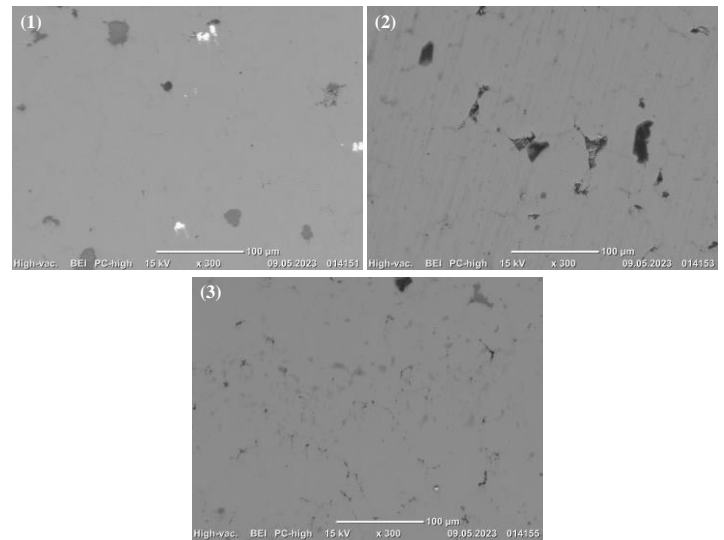


Fig. 1 SEM images of the produced samples.

The main structure of the compound is clearly seen in the SEM images given in Figure 1. It is clearly observed that Vanadium, which is added as reinforcement particles at different rates into this main structure, is homogeneously dispersed. When the SEM images given above were examined, partial cracks and pores were detected in the samples produced [11]. In addition, when the given SEM images were examined, it was determined that the amount of pores decreased and changed depending on the Vanadium addition rate. It has been determined that the homogeneous spreading of the Vanadium material in the main structure depends on the mixing of the powders during the production phase and the correct sintering process. This determined situation is supported by existing studies in the literature [12-14].

The XRD graphics of the samples produced by the powder metallurgy method are given in Figure 2. When the given XRD graphs were examined, it was determined that the phases appeared. However, there has been the presence of compounds as the dominant phases. The phases we detected in this study were also determined in current literature studies.

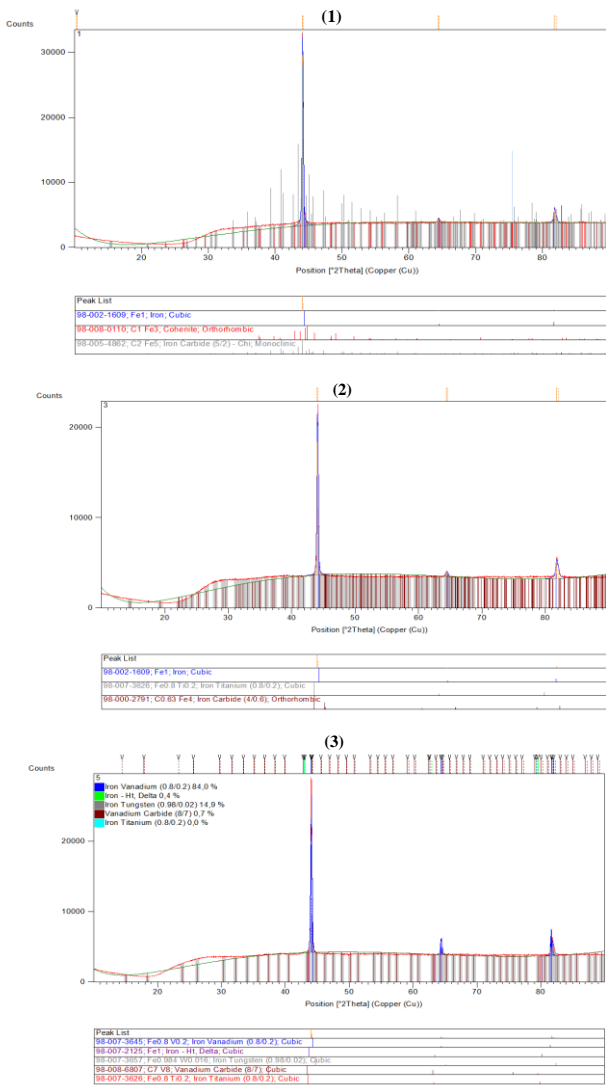


Fig. 2 XRD graphics of the produced samples.

When the graphs given in Figure 2 are examined, it has been determined as a result of XRD analysis that the phases we have determined as a result of a chemical interaction with Fe, graphite, Ti and V elements during the sintering process [15]. It was determined that the peak intensities of the phases of the compounds interacting with Fe and V increased with the increase in the V ratios of the samples produced by adding V at different rates. The peaks of the phases we detected in this study were also found in current literature studies and were supported by the literature [16-18].

IV. CONCLUSION

When the SEM images given above were examined, partial cracks and pores were detected in the samples produced. In addition, when the given SEM images were examined, it was determined that

the amount of pores decreased and changed depending on the Vanadium addition rate. When the given XRD graphs were examined, it was determined that the phases appeared. However, there has been the presence of compounds as the dominant phases. The phases we detected in this study were also determined in current literature studies.

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