Development of a Free-Sintering-Low-Alloy (FSLA) Steel for the Binder-Jet Process

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ABSTRACT

Alan Lawley's research in powder metallurgy covered a wide range of topics from atomizing to mechanical properties. Most noteworthy of his efforts was his work in alloy development. Professor Lawley was a strong believer in the relationship between microstructure, processing, and properties as it relates to the performance of the material. As new powder metallurgy (PM) processes (such as additive manufacturing) were developed, Professor Lawley helped design new alloys to take advantage of the relationship between the microstructure and the processing. This paper builds on his work in dual-phase steels to develop an alloy for additive manufacturing (AM); specifically, for the binder-jet process. This work describes a dual-phase low-alloy steel designed so that it exhibits enhanced diffusion at the sintering temperature leading to high densities. The alloy constituents are formulated, so that upon cooling from the sintering temperature, the transformation products allow the alloy to reach the required mechanical properties. In addition, the microstructure of the alloy can be varied post-sintering, by heat treatment, to give a wide range of mechanical properties that are suitable for automotive components. This alloy, called FSLA (free-sintering low-alloy), was designed and implemented based on the previous work in conjunction with Professor Lawley and demonstrates his continued impact on the PM community.

INTRODUCTION

As with many metals processing techniques, the PM processes have continued to evolve over the years and technologies such as warm compaction, injection molding, sinter-hardening, high temperature sintering, bonding, powder forging and green machining have become standard tools for the industry. Recently additive manufacturing (AM) has been the latest technology to seek acceptance as a standard PM process.[1] While there are many types of AM processes that can be classified either by the nature of the feedstock utilized (powder or wire) and/or the method by which the parts are fabricated (laser melted or glued by binder in the case of powders), one common theme is that the alloy composition (in the case of metals) and the processing must be considered together to produce a high-performing finished product. This is highlighted by Figure 1, which was