Green Body Behaviour of High Velocity Pressed Metal Powder

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Abstract

High velocity compaction (HVC) is a production technique with capacity to significantly improve the mechanical properties of powder metallurgy (PM) parts. Investigated here are green body data such as density, tensile strength, radial springback, ejection force and surface flatness. Comparisons are performed with conventional compaction using the same pressing conditions. Cylindrical samples of a pre-alloyed water atomized iron powder are used in this experimental investigation. The HVC process in this study resulted in a better compressibility curve and lower ejection force compared to conventional quasi static pressing. Vertical scanning interferometry measurements show that the HVC process gives flatter sample surfaces.

Keywords: High velocity compaction, green strength, springback, metal powder, compressibility

1. Introduction

A number of investigations of the High Velocity Compaction (HVC) process have been published in recent years [1-5]. This paper describes an experimental investigation aimed at comparing the HVC and Conventional Compaction (CC) processes in general.

2. Experimental Procedure and Results

In order to compare HVC with conventional quasi static compaction, the experiments have been performed under the same conditions. The tool set used during the experiments consists of a top punch, bottom punch and a die. The diameters of both punches were 25 mm. The heights of the top and bottom punch were 80 mm and 30 mm, respectively. The powder material used for the investigation was a press-ready mix containing Astaloy Mo + 0.3% graphite + 0.6% Kenolube, from Höganäs AB Sweden. The theoretical pore free density of this mix is 7.45 g/cm^3. The High Velocity Compaction experiments were performed using a laboratory HVC-machine with a hydraulic driven hammer. Load cell data were acquired by a high speed measuring system, capable to measure very sharp and short peak loads due to the impact, see e.g. [3]. The green tensile strength is studied by performing diametral compression of discs. The final sample height is approximately 5 mm and the diameter is 25 mm. Profile measurements have been performed with a Wyko NT1100 using vertical scanning interferometry (VSI).

The impact compaction force curve was measured during each HVC experiment. A single HVC compaction results in several force peaks, see e.g. [3]. The compaction pressure is calculated according to the first and highest force peak. In Fig. 1a the density as a function of applied pressure is shown. The HVC density curve is higher than the CC density curve. Fig. 1b shows the ejection curves that were measured of HVC and CC compacted samples. The main difference between the curves is the value of the static friction force during the first phase of the ejection. This value is approximately twice as high for CC compared to HVC. The springback is shown in Fig. 2a. The HVC samples have a lower springback compared to the CC samples which also partly can be concluded from Fig. 1b. The tensile strength, σ_f, is the maximum tensile stress value for the material. The tensile strength defined as the stress value when a large vertical crack in the centre of the disc is initiated, see [6]. Fig. 2b shows that CC discs have slightly higher tensile strength then HVC discs for equal density. The surface profile of 25 mm diameter and 5 mm high HVC and CC discs with similar densities are compared. The pressing has a single sided action applied with the top punch during compaction followed by a downward ejection. Both upper- and lower side of HVC- and CC discs have a dished profile. For comparable densities the HVC discs have a flatter upper surface, about 6 μm difference in height from the centre to the edge of the disc compared to 18 μm for CC discs, see Fig. 3a and Fig. 3b. On the lower surface, CC discs seem to have a deeper dish 35 μm compared to 25 μm for HVC, but no large differences between HVC and CC pressed discs are found regarding the lower side.

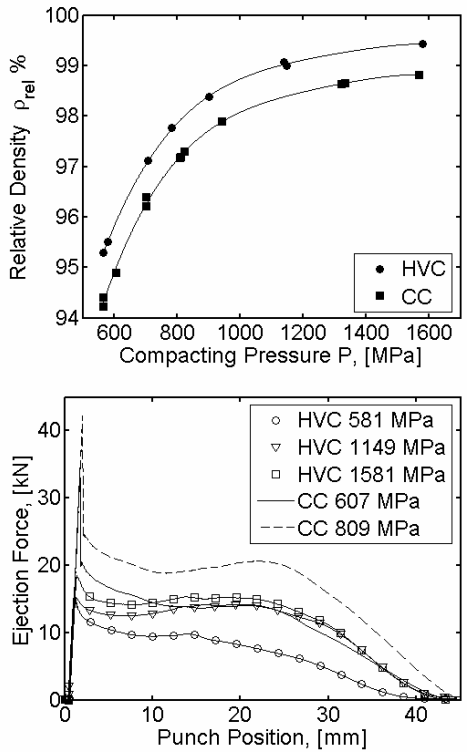

Fig. 1. a) Density vs compaction pressure for both CC and HVC. b) Ejection curves for samples compacted by HVC and CC with different compaction pressures.

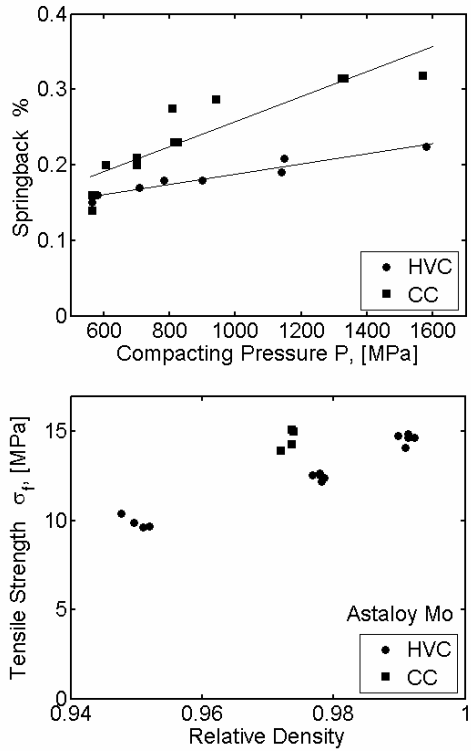

Fig. 2. a) Comparison of radial springback between CC and HVC. b) Comparison of tensile strength vs density.

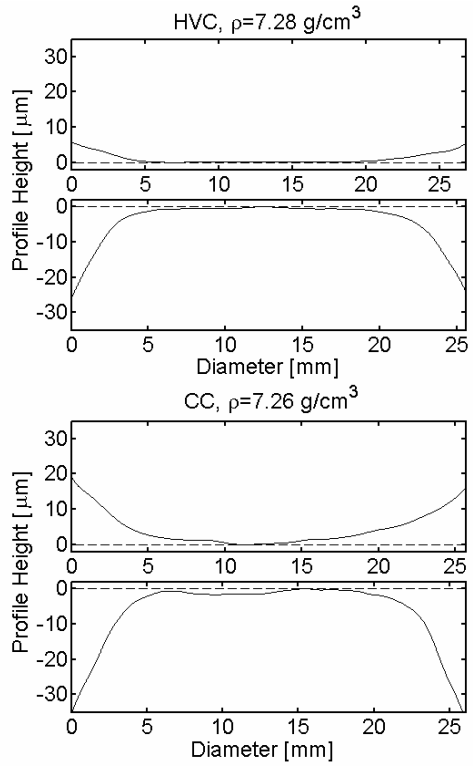

Fig. 3. a) Typical profile shape of a HVC disc, upper and lower 2d profile. b) Profile shape of a typical CC disc.

3. Discussion and Conclusions

The HVC process in this study resulted in a higher compressibility compared to conventional quasi static compaction. The HVC samples need lower ejection forces and have lower radial springback compared to CC samples. Tensile strength in green condition is slightly lower for HVC samples. Both HVC and CC samples have dished shaped end surfaces, but the surface profile of a HVC sample is flatter than for a CC sample. Both statements in the second conclusion indicate that HVC probably allows a lower lubricant consumption and still have better ejection performance compared to CC.

4. References

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