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Abstract

Electro sinter forging (ESF) is a new sintering process based on the principle of electrical Joule heating. In the present work, middle frequency direct current (MFDC) was flowing through the powder compact, which was under mechanical pressure. The main parameters are the high electrical current, up to 10 kA, and the low voltage, 1-2 V, resulting in heat generation in the powder. Figure 1 shows the experimental setup. The punches were made of a conductive material; namely a copper alloy. The die, which has to be electrically insulating, was made of alumina. The ESF process takes 3-4s including the following phases: (i) feeding of powder (ii) pre-compaction (iii) heating by electrical current during 100-200ms (iv) cooling (v) ejection. Figure 2 shows an example of measured pressure and current during sintering of the sample shown in Figure 3. As compared to conventional sintering [1] and spark plasma sintering [2], the main advantages are the decreased sintering time and high relative density [3]. The short time at high temperature avoids grain growth and creep. The compacted particles are bonded together because of high temperature at the boundaries. A theoretical model for the bonding mechanisms is described by Al-Hassani [4]. Optimization of process parameters, i.e. pressure, time and current, is needed to obtain high densification without reaching the melting temperature. The main sample properties are density, geometry and strength. In-process monitoring of the density can be done by measuring the electrical resistance during the sintering process [5], since low electrical resistance corresponds to high density. It is, however, necessary to be aware that increased temperature, on the other hand, increases the resistance. SEM micrographs and Computed Tomography (CT) are carried out for off-line pore and porosity analysis, respectively.

Figure 1: Setup.

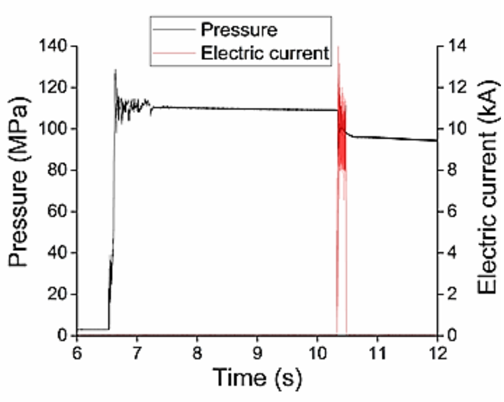

Figure 2: Pressure and current.

Figure 3: Sintered sample.

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