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THE INFLUENCE OF DC PULSE CURRENT PATTERN ON THE DIFFERENT MATERIALS PROPERTIES OF SAMPLES OBTAINED BY SPARK PLASMA SINTERING

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Spark Plasma sintering (SPS) is most advanced sintering technology that is progressively developed for the manufacture of nanostructured composites and gradient materials. This sintering method is based on a modified hot-pressing process in which an electric current is passed directly through the die and the material to be sintered rather than through an external heater. SPS is one of nanopowder consolidation methods, which apply a uniaxial pressure and thermal expansion between the raw powder and the matrix using high heating rates (from 100 to 1000 °C/min). The heating used for the sintering is meanly generated by Joule heating in a graphite matrix when a DC pulse current, created during the SPS process, crosses through them. Thanks to this, the thermal field in the sample is caused mostly by heat conduction from the matrix and others heating mechanisms as Joule heating, electrical discharges, and high-temperature plasma, associated with the electric current. The current is created by a DC pulse current generator, which can control the ON-OFF parameters of the DC pulses. Thereby, the use of pulse current during sintering promotes the appearance of spark discharges in the gap or at the point of contact between the material particles. The temperature in the spark discharge zones is in the order of about 1000 °C, which leads to local melting and/or evaporation of the raw material in very short periods of time. This leads the formation of a neck in the contact zones between the powder particles due to the mass transfer process during sintering [1,2,3]. For this reason, the study of the influence of the pulse current form on the mechanical properties of sintered samples is a very interesting field of research, which requires a lot of attention due to its practical application. Unfortunately, only few research groups are carried out investigations in this field, and they established some dependence for the sintering of specific materials under certain conditions. For instance, Xie et al [4], showed that the frequency is a factor that influences on the homogenous temperature distribution through sintering raw powder, but it has not influence on the sintered sample material properties. On the other hand, a pulsed DC current during sintering can generate very high heating and cooling rates, which enhance the diffusion mechanism of the raw material, which in turn permit the grain growth control process, and leads to a combined improvement of different material properties that include high-temperature strength and good mechanical properties such as density, toughness, flexural strength and good surface stability at the high-temperature environment [5].

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