The first reporting of microwave sintering of ceramics appeared during the 1970’s. Microwave sintering of materials is completely different from conventional sintering. Indeed, conventional sintering involves a mechanism of heat transfer by radiation, conduction and convection, so the material is heated from the surface to the inside by thermal conduction.

In opposite, it is very well know that in microwave sintering, heating is due to the conversion of electromagnetic energy into thermal energy [1] [2] [3]. In this process, the heat is generated within the material first and then heat the entire volume, which is frequently named as volumetric heating.

Until recently, microwave sintering was mostly limited to ceramics, semi-conductors, inorganic and polymeric materials. It was only in 1998 that the first attempt of microwave sintering of metal powder was published [4]. This delay is due to a misconception of researchers that all metals reflect microwave and cause plasma formation. In fact, this observation is only valid for bulk metal at room temperature and not for metal powder or for bulk metal at elevated temperature.

Since 1998, many researchers have been published results on microwave sintering of many metal powders [5] [6].

While the efficiency of microwave sintering of metal is now recognized, some studies have demonstrated the influence of the powder size and sintering temperature on the sintered density. Also, it has been shown that the heating rate and sintered density of the powders increase as the particle size decrease [7].

In this study, we propose an original system to improve the sintering and full densification of metal powder, through the combination of a microwave single mode cavity with an uniaxial pressure system (Figure 1).

The aim is to improve the sintering process by applying an uniaxial pressure during microwave heating.

Concerning the microwave system, we used a microwave frequency of 2.45 GHz delivered by a 3kW generator combined with a 10T press.

This work will focus on the microwave sintering of two types of copper powders. The difference between these two powders is the shape of the copper particles which is dendritic in the first case and spherical in the second one (Figure 2). The particle size of these two powders is in the same range, close to 30 µm.

In this paper the microstructure of the densified copper powders is characterized by Scanning Electron Microscopy coupled with EBSD analysis, in order to investigate the sintering mechanisms.

To have a complete overview of the sintering process, the microwave sintering will be compare to conventional sintering with and without pressure.
References:


