Review on Microwave Sintering Over Conventional Sintering of Different Material

Gagandeep Singh[1] Karanbir Singh Sandhu[2] Fatehpal Singh[3]
[1,2]M.Tech. Scholar [3]Assistant Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]Lovely Professional University Jalandhar, Punjab (India), Department of Mechanical Engineering

Abstract— Microwave energy is novel technology to approach the material processing with time utilization and shown significant advantages against conventional sintering procedures. The paper present a review of microwave technologies used for material processing. Microwave sintering of elemental or alloy metal has gained significance in recent time as a novel technology. The ability to process metals with microwave could assist in the manufacturing of high performance metal parts desired in many industries, for example in automotive and aeronautical industries.

Key words: Microwave, Sintering, microstructure, properties

I. INTRODUCTION

From the beginning, the microwave energy is use for food dispensation. Some time ago it became in modified way for metallic material processing. After 1999, this novel technology has been used to route metallic material. For the effective application of microwave sintering over conventional sintering is better. Microwaves can be defined as that part of the electromagnetic radiation having a wavelength ranging from 1mm to 1m in open space, and frequency ranging from 300 MHz to 300 GHz.

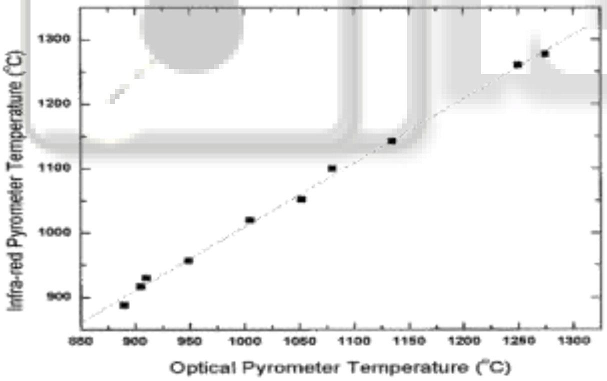


Fig. 1: Comparison of temperature infrared optical pyrometers

ROY[2005] had explained the microwave heating of materials is basically different from conventional heating, in microwave the heat is generated internally within the whole conservative process, and succeeding heat transfer involving a thermal conductivity appliance. Microwave sintered material have remarkably achievement, such as higher flexural strength, higher tensile strength and Rockwell hardness. The range of frequencies for microwave handing out is 3 KHz to 30 KHz, 300 KHz to 3MHz, 3MHz to 30MHz, 30MHz to 300MHz, 300MHz to 3GHz, 3GHz to 30GHz, 30GHz to 300GHz.

The applicability of microwave sintering to metals has been simply overlooked for the decent reason that most metals are known to reflect microwaves.

The sintering community has explicitly passed over even the possibility of their sintering using microwaves. Very few papers have been found reporting the microwave sintering of powder metal alloys although a couple of papers do report the modest heating using microwave.

Microwave heating results in lower energy costs and decreased processing times for many industrial processes. In ceramics, it can be used for sintering, mixture, ventilation and rebinding. Yadoji et al. [1] developed sintering of Ni-Zn ferrites. The focus of worked was comparison with conventional technique. The researcher used the parameter temperature and time for sintering was 1275 degree C for 30 minute. The comparison illustrate that, there is less and small pores in microwave sintered sample, but in conventional sintered specimen pores was more. Magnetic properties of the work are revealing on M-H graphs for Ni-Zn ferrite. Coercively value for sample is low over magnetization. Conventionally sintered sample exhibit higher indication of dielectric constant values of sample is small over conventional technique.[9]Most significantly samples sintered in a microwave field, generally displayed lower dielectric constant value associated with the samples sintered conventionally, making microwave sintering particularly suitable for high frequency claims. Kristen et al.[2] had did microwave processing of alumina by using the process sintering. The work is done on comparison with conventional technology about density with temperature variation. Grain formation is same for both processes by reason of temperature variation. Infrared pyrometer measured microwave heating.[10-11] Study reveal, the less time consume by microwave sintering for material treating at lower temperature compare to conventional sintering. Grain cultivated from 1.0 µm at 86% density to 2.6 µm at 98% density for both conventionally sintered and microwave sintered samples. Tian, Johnson and Brodwin fast-fired MgO-Dopod alumina (Baikal ox CR-30, Baikowski international Corp. Charlotte, NC) at 1700 Ċ for 12 min in a 2.45 GHz microwave furnace to attain 99% and 99.8% densities for 0.8 and 1.9 µm final grain sizes respectively.

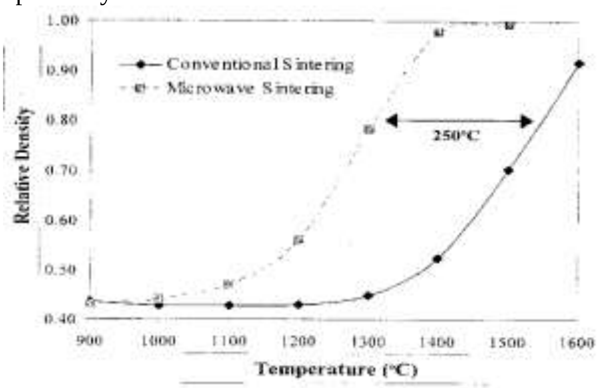


Fig. 2: Density of microwave-sintered and conventionally sintered alumina samples as a function of sintering temperature with zero soak time.

Anklekar et al. [3] in this study the work did on the PM copper steel (MPIFFC-0208 composition) follow both method (microwave and convention).process microwave 2.0 kw with 2.45 GHz is used. Recent reviews on microwave processing by Clark and Sutton, Schiffman, Katz and Sutton designate its possible use for a wide range of materials from wood, bacon and potato chips to rubber, ceramics, and semiconductors. Ferrous alloys are widely used in powder matalLurgy. MOR bar samples sintering prepared in the graft with the size of 31.85 x 12.80 x 6.95mm±0.10mm.[14-15]PM copper steel achieved the properties by microwave technique is better over conventional method. The properties come to picture is high flexural strength, higher tensile strength and higher Rockwell hardness.

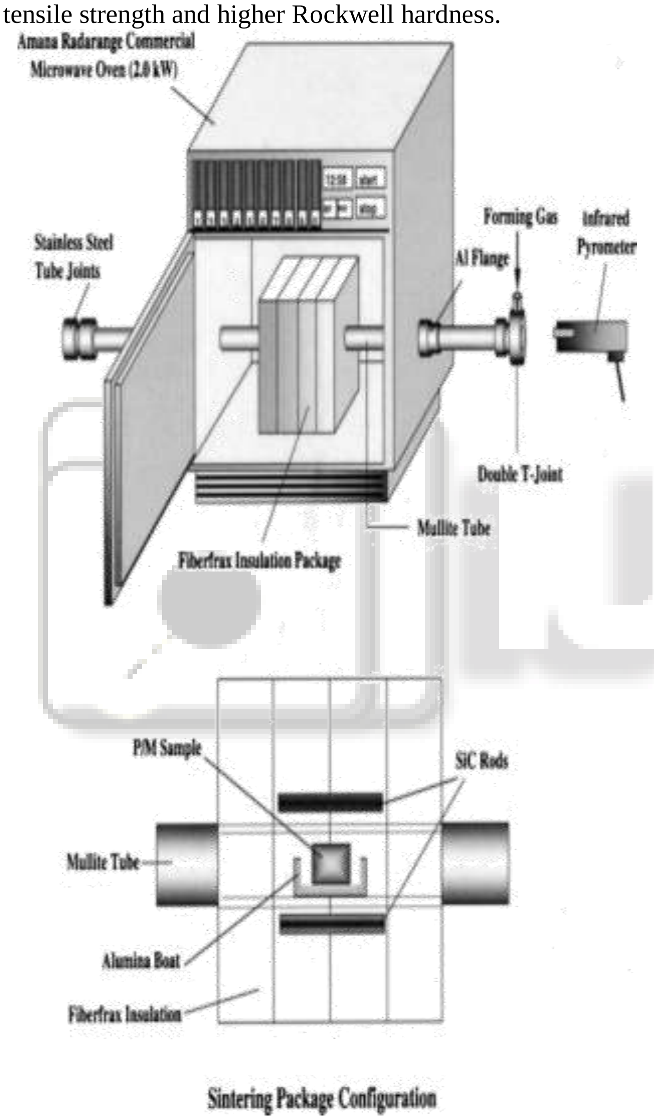
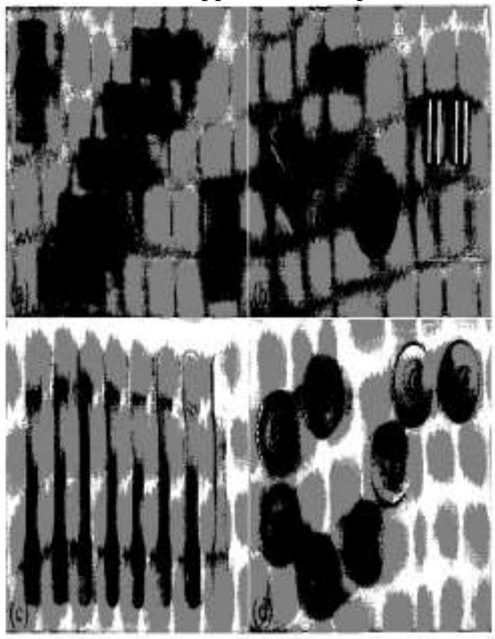


Figure 3 Schematic diagram of microwave sintering set up.

Bauer et al.[2005][4] have developed the comparison analysis between both method. Copper and nickel steel pm parts study shows that, microstructural properties is far better in microwave process study reveal the novel technique produce no. of advantages over conventional criterion. Improved mechanical properties and microstructural development of copper and nickel PM parts depicts by microwave sintering.

Densification value of microwave sintering is satisfy and dense property of microstructure can be proved in the microwave sintered pm parts. Results illustrate properties like higher toughness, higher flexural strength and improving sintering time. Cu and Fe also resulted that, more uniform distribution of alloying elements at Nano and micro level. In the present investigation, an admixed alloy powder of copper steel, Atomet AXD 3401 sourced from Quebec metal powders limited, Canada, was used to fabricate the FC-0208 copper steel PM parts.



a FC-0208 modulus of rupture bars, b FC-0208 and FN-0208 cylindrical tubular samples, c FN-0208 tensile bar specimens, d FC-0208 pinion gears

Fig. 4: Digital camera photographs of PM parts fabricated using conventional and microwave sintering techniques.

The comparison of sintered density and other mechanical properties obtained for the FC-0208 and FN-0208 composition steel PM fabricated parts processed using both the conventional and microwave sintering arrangements. Geng-fu Xu et al.[2001][5] The aim of work is improve microstructure of zinc oxide, when we using high heating rates(4900 degree C/min).Different properties are achieved with high heating rate, either it will mechanical, thermal, dielectric and optical. All the properties are depend on the microstructure. Heating rate variation influence the grain growth, density and densification technique. Result exposed, grain size very fastly diminished with collective heat. Study told all samples prepared from commercial high purity ZnO powder (CERAC, Inc., Milwaukee, WI, 99.9% purity, 1.2-µm median particle size). Microwave heating was performed in atmospheric pressure air using a high-tech overloaded 2.45-GHz applicator. De et al. used hybrid microwave heating to attain a peak-heating rate of 750 degree C/MIN in pure alumina using a 2.45-GHz multimode applicator [5].

II. CONCLUSION

Microwave sintered material having more importance over conventional technology. Properties of material are improve, such as grain growth, microstructure of different properties. Microwave sintering also improve sintering time, sintering temperature, total cycle time and density. Finally, microwave sintering have reliable scope for future. Grain growth exponents of 12 and 5 were respectively obtained for slow heating rates and ultra-rapid heating. These results are very promising with respect to obtaining controlled, tailored microstructures in ceramics.

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