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A Review on Powder Metallurgy of Iron Oxide and Iron

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***Abstract*- This paper deals with study of various composites fabrication by powder metallurgy and testing of their different mechanical properties and microstructures. The major controlling factors in fabrication are size of powder, blending timing and method, pressing pressure of dies, temperature and timing of sintering and cooling type. Composites fabricated by powder metallurgy are found to be of higher strength the hardness with fine reinforced microstructures.**

Keywords: Powder metallurgy, Fe_2O_3, Fe, sintered.

I.INTRODUCTION

Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material (sintering). Blending is mixing powders of the same chemical composition of same or different sizes. It can be accomplished mechanically or manually. After blending the powders, Blended powers are pressed in dies under high pressure to form them into the required shape (known as green compact). Further this green compact is heated in a controlled-atmosphere furnace to a temperature below its melting point, but high enough to allow bounding of the particles (sintering) and then it is cooled. Finally the finishing operations applied on compressed material.

Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. Powder metallurgy is very effective method for the fabrications of composite materials.

II. LITERATURE REVIEW

Shivendra Kumar, Fabrice Mathieux, Godfrey Onwubolu and Vineet Chandra[1] recycled Al by a novel powder metallurgy-based method to prevent rapid overflowing of landfills by scrap metals. First of all they converted scrap Al into the powders of 9.5mm, 2.5mm, 500µm and 250µm aperture. To bind and lubricate the powder, 3% volume ethanol and 1% mass zinc stearate added to Al powder. The mixture was compressed at 3.5MPa by hydraulic press and sintered at 585^0Cin atmospheric pressure. On the bases of experiments it was found that with increase in compression pressure density increases, the compaction percentage increases with increase in grain sizes and Brinell Hardness Number (BHN) of scrap Al is higher than that of pure Al.

Mohammed Baba Ndaliman and Ahsan Ali Khan[2] developed the Cu-TaC Electrodes for EDM by Powder Metallurgy and investigated their properties for suitability to EDM. 30 and 55% weight of TaC powders were mixed with Cu and manually pressed into electrodes of 13mm diameters on pellet press. Mixtures containing 30 and 55% of TaC were sintered at temperatures of 450 and 850^0C for 25 and 50 minutes respectively on the bases of Design of Experiment. Electrical conductivity, thermal conductivity and density of various electrodes were calculated. It was found that the compacted electrodes in green form (without sintering) were favourable for EDM as these had better electrical and thermal conductivity and density between 6.13 and 9.80 g/cm^3. But sintered electrodes becomes non-conductive electrically and unsuitable for EDM.

Chinawad DHADSANADHEP, Tachai LUANGVARANUNT, Junko UMEDA2 and Katsuyoshi KONDOH[3] fabricated composites of Al/Al_2O_3 with silica (in form of rich husk ash) and cooper powders. Al, Cu and Silica powders of 106, 70 and 250 µm mean size respectively were mixed by shaking in a plastic bag for 20 minutes. The composition of mixture taken as Al-4wt.%Cu / 5vol.%Silica, Al-4wt.%Cu / 10vol.%Silica, and Al-4wt.%Cu / 15vol.%Silica and cold compacted in a 30mm diameter die under 214 MPa pressure, followed by sintering at 650^0C for 1 hour under Ar gas. And it was heat treatment between temperatures 590 to 650^0C for 10 hours. From X-ray diffractometer (XRD) it was noticed that in-situ reaction between silica and Al powders occurred above 590^0C during heat treatment. Also the hardness of composite increased with increase in amount of silica.

Nemes Toderita, Nemes Catalin and Isarie Claudiu[4] were fabricated valves for automobile by mixing powders of austenitic stainless steel AISI 316 L as base, 0.5% zinc stearate with 10%, 20% & 30% proportions of Al_2O_3 and pressed mixtures at forces of 400kN and 200kN. This was followed by sintering the mixtures at a temperature of 1200^0C for one hour and cooled in still air. It was found that higher alumina content is lighter because of a constant filling volume in the mold; specific weight of alumina is lower than stainless steel. On the bases of micro structural inspection it was observed that mixture containing 20% of Al_2O_3 had most uniform structure and least variations in mass.

Rajesh Purohit, R. S. Rana and C. S. Verma[5] fabricated and tested the mechanical properties of Al-SiC_p Composite.

SiC powder (of six different compositions 5, 10, 15, 20, 25 and 30%) with 0.5% of Mg (to increase wettability) was mixed with base powder manually in a plastic container. The mixture was than mechanical alloying which results in mixing at molecular level. Mixture in flexible mould was compacted to 600MPa pressure at loading rate of 3.27 KN/second to provide better and more uniform properties. Further it was pressed at 500KN in die set-up and sintered in a muffle furnace by gradually raising temperature to 580^0C for 30 minutes and compacts were furnace cooled. Vacuum sintering of the Al-SiCp composites was also done which gave better properties. After testing it was found that hardness, density, porosity, compressive strength and indirect tensile strength were increased with increase in percentage of SiC_p. Also mechanical alloying improved hardness and compressive strength.

H. Danninger, Ch. Harold, Ch. Gierl, H. Ponemayr, M. Daxelmueller, F. Simancik and K. Izdinsky[6] manufactured carbon-free precipitation hardened high speed steels. By blending Fe-25%Co-15%Mo and Fe-20%Co-15%Mo for 60 minutes in a tumbling mixer and then uniaxially compacted at 400 MPa under die wall lubrication. The compacts were sintered for 120 minutes at $1230–1400^0$C in presence of hydrogen. This resulted into excellent combination of hardness and transverse rupture strength. Also heat treatment resulted into chemically homogeneous and fine-grained microstructure.

Sagar V. Wankhede, Samir L. Shinde, Amit R. Wasnik[7] created Cu-Al_2O_3 metal matrix composites by Powder Metallurgy. The copper matrix composite of 45μm size was reinforced with 5%, 10% and 15% of alumina particles of 10μm size. These mixtures than pressed at forces of 350, 400 and 450 MPa and further the compacts were sintered in Hydrogen atmosphere at a temperature of 800^0C for 1 hour followed by cooling in furnace. It was observed that powder dispersion, and mechanical properties such as micro hardness were improved by sintering and cold compaction.

III.CONCLUSION

Powder metallurgy is impressive method for the fabrication of the different composites of improved mechanical properties and microstructure. Mean size of powders for blending, pressure to which the mixture is pressed, sintering temperature of the green are the considerable governing factors for the fabrication of composites by powder metallurgy.

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