



Developments in Sintering Process: Sinter-HIP

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Introduction

Sintering process is known as compacting and forming a powder material by heat and pressure and resulting on a high relative density and superior mechanical and physical properties. Parallel to technological developments, relative density values near to 100% are reached in atmosphere controlled sintering furnaces. The sintering process applied for the manufacture of P/M parts close to 100% relative density has three stages and the steps applied are briefly as follows,

After compaction, lubricant and binders, which facilitate the compaction process, is removed by atmosphere controlled chamber furnace at low temperature using physical and chemical methods.

During sintering under protective gas and vacuum environment, relative density reaches to 90% which depends on the desired temperatures and time in the process.

Apart from the above two steps, this step aim is to increase relative density up to 100%. For gaining higher density, sintered parts are placed into hot isostatic pressure (HIP) sintering. At this process, sintered parts is compacted at pressure up to 200 MPa under Ar or N₂ atmosphere at temperature close to the conventional sintering.

The main advantage of using HIP process rather than conventional sintering process is that compressive force is exerted on all surfaces of the sample by the gas atmosphere pressurization. Also, this process is carried out at high temperatures leads on increases the diffusion mechanism among powders under compaction [1].

Technological developments in the atmosphere controlled furnace, modern sintering furnaces develop high pressure and vacuum environments at one place. Three stages of sintering can be done in the same furnace. Therefore, it saves time and cost and leads new development ideas for researchers and P/M industry.

As mentioned above, Sinter-HIP is a new sintering method of thermal consolidation for samples wherein the simultaneous application of heat and pressure fully consolidates during the sintering process. It results in a product that contains very small even no porosity, thereby producing a component that is as close to full theoretical density as possible.

Sinter-HIP process must be distinguished from post-HIP. In the Sinter-HIP process, sintering and HIP operation are combined into a

single process step while post-HIP, the sample is sintered then placed in a separate furnace to be re-heated and have pressure applied [2]. This main differences makes Sinter-HIP samples a superior product because of using higher temperature and lower pressure than post-HIP. Other known differences between Sinter-HIP and post-HIP are given below,

Depending on sample properties, high pressures in the levels reaching 200MPa in post-HIP process, thereby microstructure segregations may occur in the sample. However, relatively low pressures in the Sinter-HIP process eliminates these effects.

Thanks to single-chamber process of Sinter-HIP, the oxygen removal process is performed one time while the post-HIP process is performed twice time because of its processing step. So, it reduced the process costs by half.

As a result, sintering has developed by using new techniques and mechanisms. Sinter-HIP is a good example for P/M sintering process development in last decade. Because of eliminating porosity and increasing mechanical properties of P/M parts, Sinter-HIP gives many opportunities for P/M industry by saving their time and costs than other conventional sintering methods.

Most important application of Sinter-HIP process is production of hardmetals and ceramics. Conventional Hot Isostatic Pressed hardmetals, depending on the composition and porosity rate of PM parts, at pressure up to 100 MPa sintering gas atmosphere absorbs gas very high values. Therefore, density of HI Pressed PM parts can not be reached up to 100% value. On the contrary, Sinter-HIP processed PM parts, because of lower gas pressure, gas absorbing can not be observed.

As a result, Sinter-HIP process for sintering hardmetals and ceramics which are used for making cutting tools for machining some important metals like Ti alloy, Inconel 718, has more advantages than commercially HIP processes.

References

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