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A Review on –Mechanical Properties and Composition of Incoloy alloy-825 reinforced Aluminum alloy-7075 metal powders, Methods & Applications

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Abstract: In the present work, The Mechanical and Physical properties of AL-7075 alloy and Inconel-825 alloy and material composition with various applications is seen. So the main content here in this literature survey came to know the methodology of Powder metallurgy process with these materials has noticed. And the following references are seen to use this process.

Keywords: Materials, Properties, Powder Metallurgy, Applications.

1. Introduction

Inconel Alloy 825

Incoloy alloy 825 is a nickel-iron-chromium alloy with additions of molybdenum, copper, and titanium. The alloy's chemical composition, given in Table 1, is designed to provide exceptional resistance to many corrosive environments. The nickel content is sufficient for resistance to chloride-ion stress-corrosion cracking. The nickel, in conjunction with the molybdenum and copper, also gives outstanding resistance to reducing environments such as those containing sulfuric and phosphoric acids. The molybdenum also aids resistance to pitting and crevice corrosion.

Fig. 1: Inconel 825 alloy

The alloy's chromium content confers resistance to a variety of oxidizing substances such as nitric acid, nitrates and oxidizing salt. The titanium addition serves, with an appropriate heat treatment, to stabilize the alloy against sensitization to intergranular corrosion.

The resistance of Incoloy alloys 825 to general and localized corrosion under diverse conditions gives the alloy broad usefulness. Applications include chemical processing, pollution control, oil and gas recovery, acid production, pickling operations, nuclear fuel reprocessing, and handling of radioactive wastes. Applications for alloy 825 are given below

Table 1 - Chemical Composition of Incoloy alloy 825

Material	**Composition (%)**	**Material**	**Composition (%)**
Nickel	38.0-46.0	Manganese	1.0
Iron	22.0	Sulphur	0.03
Chromium	19.5-23.5	Silicon	0.5
Molybdenum	2.5-3.5	Aluminium	0.2
Copper	1.5-3.0	Titanium	0.6-1.2
Titanium	0.6-1.2		

Physical Constants

Some physical constants for Incoloy alloy 825 are listed in Table 2. Modulus of elasticity and Poisson's ratio over a range of temperatures are given in Table 4. Modulus values, which were determined dynamically, were used to compute Poisson's ratio.

Physical Properties

1. Density = 8.13 g/cm^3
2. Hardness = 83-85 HRB
3. Modulus of Rigidity = 75.9 N/mm^2
4. Melting Point = 1300-1400 °C
5. Coefficient of expansion = 14.0 m/m/c
6. Modulus of Elasticity = 196 KN/mm^2

Typical Inconel alloy grades

- Inconel 188: It is readily fabricated for commercial gas turbines and aerospaceapplications.

- Inconel 230: This plate is mainly used by the power, aerospace, chemical processing and heating industries, aerospacematerials.

- Inconel 600: It is a solid solutionstrengthened.

- Inconel 617: It is a solid solution strengthened, high temperature strength, corrosion and oxidation resistant and high weldability.
- Inconel 625: Acid resistant and good weldability.
- Inconel690: It is a Low cobalt content for nuclear applications, and lowresistivity
- Inconel 713C: It is a precipitation hard enable nickel – chromium base castalloy.
- Inconel 718: Gamma double prime strengthened with good weld ability.
- Inconel X-750: It is used in gas turbine components, including blades, seals androtors.
- Inconel 751: Increased aluminum content for improved rupture strength of 1600^0F.
- Inconel 792: Increased aluminum content improved high temperature properties and used in gasturbines.
- Inconel 825: In this sufficient amount of Nickel content is there for various experimental works and gives good required applications.
- Inconel 939: It is gamma prime strengthened to increase weld ability.
- Inconel 925: It is non stabilized austenitic stainless steel with low carboncontent.

Mechanical Properties

Incoloy alloy 825 has good mechanical properties from cryogenic temperatures to moderately high temperatures. Exposure to temperatures above about 1000°F (540°C) can result in microstructural changes (phase formation) that significantly lower ductility and impact strength. For that reason, the alloy is not normally used at temperatures where creep-rupture properties are design factors.

As indicated, the alloy can be strengthened substantially by cold work.The tests were conducted on cold-drawn rod of 0.75-in. (19-mm) diameter annealed at 1725°F (940°C)/1 hr. Compressive yield strength of the alloy is similar to tensile yield strength.

Tests on annealed rod of 1.0-in. (25-mm) diameter produced a compressive yield strength (0.2% offset) of 61,400 psi (423 MPa) compared with a tensile yield strength of 57,500 psi (396 MPa). Ultimate tensile strength of the material was 104,500 psi (720 MPa). INCOLOY alloy 825 has good impact strength at room temperature and retains its strength at cryogenic temperatures. Table 6 gives the results of Charpy keyhole tests on plate.

Corrosion Resistance

The outstanding attribute of Incoloy alloy 825 is its high level of corrosion resistance. In both reducing and oxidize environments, the alloy resists general corrosion, pitting, crevice corrosion, intergranular corrosion, and stress-corrosion cracking. Some environments in which Incoloy alloy 825 is particularly useful are sulfuric acid, phosphoric acid, sulfur containing flue gases, sour gas and oil wells, and sea water.

Fabrication

Incoloy alloy 825 products are heat treated during manufacturing at the mill to develop the optimum combination of stabilization, corrosion resistance, mechanical properties, and formability. To maintain these properties during fabrication, subsequent anneals should be performed between 1700 to 1800°F (930 to 980°C) followed by rapid air cooling or water quenching.

Heat treatment in the lower end of the range is acceptable for stabilization. However, annealing at temperatures in the higher end of this range may be preferred for softness and grain structure for forming and deep-drawing while maintaining corrosion resistance.

Quenching is usually not necessary for parts of thin cross section (e.g., sheet, strip and wire), but may be desired to avoid sensitization in products of heavier cross section. General procedures for heating, forming, pickling, and finishing are found in the SMC bulletin “Fabricating”. Welding, brazing, and soldering techniques are discussed in “Joining”.

Hot and Cold Forming

The hot-working range for Incoloy alloy 825 is 1600 to 2150°F (870 to 1180°C). For optimum corrosion resistance, final hot working should be done at temperatures between 1600 and 1800°F (870 and 980°C). Cooling after hot working should be air cool or faster. Heavy sections may become sensitized during cooling from the hot-working temperature, and therefore be subject to intergranular corrosion in certain media.

A stabilizing anneal (see above) restores resistance to corrosion. If material is to be welded or subjected to further thermal treatment and subsequently exposed to an environment that may cause intergranular corrosion, the stabilizing anneal should be performed regardless of cooling rate from the hot-working temperature.

Cold-forming properties and practices are essentially the same for Incoloy alloy 825 as for Inconel alloy 600. Although work-hardening rate is somewhat less than for the common grades of austenitic stainless steels, it is still relatively high. Forming equipment should be well powered and strongly built to compensate for the increase in yield strength with plastic deformation.

Machining

All standard machining operations are readily performed on Incoloy alloy 825. The alloy normally has optimum machining characteristics in the annealed temper. Tooling and procedures described for Group C alloys should be used.

Joining

Incoloy alloy 825 has good weldability by all conventional processes. For most applications, Inconel Welding Electrode 112 for shielded metal-arc welding and Inconel Filler Metal 625 for gas-shielded processes are used. For applications that require highest resistance to corrosion, INCO-WELD Welding Electrode 686CPT and INCO-WELD Filler Metal 686CPT are used. Information on surface preparation, joint design, and welding technique can be obtained in the Special Metals publication “Joining”.

Heat Treatment

Incoloy 825 is stabilize annealed at 940°C. The softest structure is obtained at 980°C. Sections heavier than sheet, strip and wire should be quenched to avoid sensitisation.
Please consult Austral Wright Metals for specific advice on your application.

Applications of Incoloy alloy 825

Typical Applications of Incoloy Alloy 825 include:

- Sulphuric acid piping and vessels
- Phosphoric acid evaporators
- Pickling tank heaters, pickling tanks and equipment
- Chemical process equipment
- Propeller shafts
- Tank trucks
- Calorifiers
- Electrostatic precipitator electrodes
- Hot vessels for food, water and seawater,

- Ammonium sulphate vessels
- Expansion bellows
- Marine exhaust systems
- Power station ash hoppers

Aluminium (Al) As A Metal Matrix:-

Aluminium is the most popular matrix for the metal matrix composites (MMCs). The Al alloys are quite attractive due to their low density, their capability to be strengthened by precipitation, their good corrosion resistance, high thermal and electrical conductivity, and their high damping capacity.

Aluminium matrix composites (AMCs) have been widely studied since the 1920s and are now used in sporting goods, electronic packaging, armours and automotive industries. They offer a large variety of mechanical properties depending on the chemical composition of the Al-matrix. They are usually reinforced by Al2O3, SiC, C, TiO2 but SiO2, B, BN, B4C may also be considered**.** In addition, literature also reveals that most of the published work has considered Aluminium-based composites with their attractions of low density, wide alloy range, heat treatment capability and processing flexibility**.**

Aluminum (Al-7075):

The matrix material to be used was chosen as Al7075 which is a precipitation hardened aluminum alloy, containing zinc, magnesium, copper, and chromium as its major alloying elements. It has good mechanical properties and it is strong with strength comparable to many steels, has good fatigue strength and less resistance to corrosion and many others.

Fig. 2:- Aluminium alloy (Al7075)

Table 2:- Chemical Composition of Aluminium Al-7075

Element	%Weight	Element	%Weight
Si	0.4	Cr	0.28
Cu	2.0	N	-

Mg	2.9	Zn	6.1
Mn	0.3	Ti	0.2
Fe	0.5	Zr	-

Table 3:- Properties of Aluminium Al-7075

Properties	Density g/cc	Melting Point ^{0}C	Tensile Strength Mpa	Fatigue Strength Mpa	Hardness HB
Al7075	2.8	627	572	160	60

2. Literature Reviewon Materials

1) Inconel Alloy

A review of major contributions to the field of machining optimization related to this research is reviewed. The machinability study of INCONEL reviews the relationship between the input and output machining process parameters and the economics of machining. Many of the researchers worked in this area in different directions and their research findings are listed below.

Review on Characterization of borided Incoloy 825 alloy:

Author: **Halil Aytekin (2013)**

Incoloy 825 alloy is an alloy with high corrosion resistance but it has low strength and hardness. Increasing of hardness of the alloy is important for its wear resistance. In this study, Incoloy 825 alloy was boronized to increase its hardness. The boronizing process was carried out using the box boronizing method at 900 and 950 °C for 2, 4 and 6 h. The coating thickness that occurred by boronizing increased with the increase in temperature and time. The thickness of boride layers depending on temperature and process time was ranged from 35 to 170 µm. The presence of borides (e.g., FeB, Fe2B, CrB, NiB) was confirmed by X-ray diffraction (XRD) analysis technique. The boron compounds have shown the random distribution. The microhardness has decreased along the coating thickness (towards to the matrix).

Review on Microstructure Characterization in Alloy 825":

Author: **Munir Al-Saadi (2018)**

Hot-compression tests down to 0.7 in nominal strain were conducted at a strain rate of $1s^{-1}$ between 800 and 1200 °C. The material was taken from the columnar and equiaxed zones of a continuous cast strand of Alloy 825. Furthermore, recrystallization was determined using LOM and FEG-SEM equipped with an EBSD-detector. The true stress of the columnar structure was a 0.2% lower than for the equiaxed microstructure for the studied deformation temperatures. The optical and EBSD images in both structures showed that a dynamic recrystallization had almost not occurred. Instead, a substructure formation with mostly low-angle grain boundaries dominated was found.

Review on Machinability of Nickel-Based High Temperature alloys:

Authors: **Arunachalam and Mannan (2018)**

These two have discussed that high speed machining in comparison with conventional machining, it is possible to drastically improve the material removal rate. Dudzinski et al (2004) focused on recent advances concerning machining of Inconel718. The associated costs of coolant acquisition, use, disposal and washing the machined components are significant, up to four times the cost of consumable tooling used in the cutting operations. To reduce the costs of production and to make the processes environmentally safe, the goal of the aeronautical manufacturers is to move toward dry cutting conditions.

Review on Localized Corrosion Charecteristics of Nickel alloy:

Author: **Helmuth Sarmento Klapper (2017)**

There are a great variety of commercial nickel alloys mainly because nickel is able to dissolve a large amount of alloying elements while maintaining a single ductile austenitic phase. Nickel alloys are generally designed for and used in highly aggressive environments, for example, those where stainless steels may experience pitting corrosion or environmentally assisted cracking. While nickel alloys are generally resistant to pitting corrosion in chloride-containing environments, they may be prone to crevice corrosion attack. Addition of chromium, molybdenum and tungsten increases the localized corrosion resistance of nickel alloys. This review on the resistance to localized corrosion of nickel alloys includes specific environments such as those present in oil and gas upstream operations, in the chemical process industry and in seawater service.

Review on Flank wear measurement of Inconel 825:

Author: **Vivekanand Munde (2017)**

In modern metal cutting operations, it is of the at most importance to increase the material removal rate with a good surface finish and high machining accuracy. Machining process results in a high tool wear while performing number of operations and it will take substantial amount of time. Cutting tool cost is one of the most important components of machining costs. The life of the cutting tool plays a major role in increasing productivity and consequently is an important factor. Therefore, it is important to account tool wear for various cutting conditions. In this paper our focus is to measure the tool flank wear on Inconel 825 material on CNC machine and conventional Lathe machine.

Tool wear

One of the most important and widely used machinability characteristics is tool life for any cutting tool. Much research attention has been directed towards enhancing tool life which can be improved by proper selection of machining parameters, tool material, use of coolant, tool coating etc. It is very important to understand the various mechanisms of tool wear for the improvement of tool life. Tool wear refers to the degradation of cutting or clearance surface, reduction in some of the mechanical properties of the tool and its fracture.

Review on Optimization of Process parameters for WEDM of Inconel 825 using grey relational analysis:

Author: **Pawan kumar (2018)**

Recent developments in mechanical industry have increased the demand of superalloys because of their high-strength, temperature, corrosion and oxidation resistant properties (Aggarwal et al., 2015). Superalloys retain their mechanical properties at high temperature which make them useful in marine, space, aero-engine components and other applications (AKCA and Gursel, 2013). Several generations of Inconel series have been developed such as Inconel 600, 601, 718, 800, 825 etc (AKCA and Gursel, 2013). Inconel 825 possesses superior mechanical properties compared to Inconel 718 as it provides better resistance to chloride pitting and corrosion.

Review on Machining of Nickel-Base, Inconel 718 Alloy with ceramic Tools:

Authors: **Ezugwu et al and J.Bonney (2005)**

Has conducted several experiments and concluded that prolonged machining of Inconel 718 results in steady increase in cutting force, power consumption, flank wear and nose wear.

Review on Cutting forces and wear in Dry Machining of Inconel 718 with coated Carbide tools:

Author: **Devillez et al (2007)**

Has conducted several experiments on Inconel718 with different coated tools and different cutting conditions. The elementary orthogonal cutting process was chosen, the cutting and feed cutting forces components were measured and the cutting force ratio calculated. This ratio is shown to be an interesting indicator of tool wear. A correlation was found between the tool wear and the consumed spindle power.

Arunachalam (2007) have conducted a study to investigate the performance of mixed alumina ceramic tools in high speed facing of solution annealed Inconel 718. It is observed from several experiments that the effect of cutting speed on the tool wear is more pronounced than the effect of feed rate and depth of cut. In general with the increase in the cutting speed, the cutting forces showed a decrease trend, whereas with increase in feed rate and depth of cut, the cutting forces showed an increasing trend.

Review on effect of cutting speed on tool wear and tool life when machining Inconel 718:

Author: **Altin et al (2007)**

Has investigated the effects of cutting speed on tool wear and tool life when machining Inconel 718 nickel; based super alloy. Several experiments are conducted and it is seen that flank wears are usually dominant wear types in cutting tools.

Review on Surface Integrity in Cryogenic machining of Nickel based alloy Inconel 718:

Author: **Pusavec et al (2011)**

Has developed a comparison for different combinations of cooling and lubrication machining conditions of Inconel 718. With these different set of combinations, the surface integrity characteristics of machined surface as a function of depth have been analyzed. The cryogenic machining process can be implemented to improve all major surface integrity characteristics, thus improving the final product quality level. It is shown that dry machining conditions are the best suited conditions for machining Inconel 718.

2) Al-7075 alloy

Fracture analysis of turbine disks and computational experimental background of the operational decisions:

Author: **V.N. Shlyannikov, B.V. Iltchenko, N.V. Stepanov**(2001)

Has conducted experiment on Fracture failures of rotating compressor disk and turbine blade of civil aircraft engines were detected. Their fracture was the result of crack initiation and propagation until a critical crack length has been reached. In all of these failures, crack propagation started from a part-through surface crack defect.

Stress intensity factor equations for cracks in three-dimensional-finite bodies:

Author: **Newman JC, Raju**

Hasexamined on the 2D solution by Newman and Raju to estimate the stress intensity factors (SIF) for corner quarter-elliptical and half-elliptical part through surface cracks with complex configuration in variable stress fields has been shown to be quite useful.

The analysis of surface crack problems becomes extreme as the front of a part through crack approaches intersection with the plate (or hole) surface. Therefore, the crack growth of the surface flaw should be calculated in both the depth a and surfaceb directions. The ratio between the depth and surface length is referred to commonly as aspect ratio of the crack ε. To describe the elastic SIF distribution at any point along the crack front in a rotating disk, we have used a numerical solution by Newman and Raju obtained from the 3D finite element analysis.

Elastic stress intensity factors for disk and blade attachment of gas turbine engine. Problems of Strength:

Author: **Shlyannikov VN, Iltchenko BV**

Hascarried out on this solution was supplemented approximate method for the SIF value estimates applicable to part-through surface cracks in gas turbine engine disks. The addition consists in taking into account the gradient of the nominal stress distribution (obtained in the previous section) at three points in crack growth direction. A schematic of the disk fragments indicating the geometrical parameters of the crack zone is found.

Modelling of crack growth by fracture damage zone:

Author: **Shlyannikov VN**

Hasanalyzedfor both static and cyclic loading conditions, the concept of the fracture damage zone (FDZ) is proposed, according to which the realization of the leading fracture micro mechanism, so-called decohesive (brittle) or coalescent (ductile) one, depends on the ratio between the FDZ size and that of the crack tip plastic zone. The FDZ size has been considered as a fundamental characteristic setting interrelation between the processes occurring on both micro- and macroscale level with respect to the material structure. The FDZ ahead of the crack front is assumed to be located where the stress-strain state in the element reaches a certain critical value that can be measured from standard test data.

Similarity of disk stress states and damage on multiaxialhydraulic test bed to those in service operation:

Author: **Stepanov NV, Shkanov IN, Omelchenko VV**

The nature of work is on the configuration of the BHS is given at selected intervals during the fatigue testing; visual inspection of the surface of the hole was made using the wink-zyglo technique (the surface was coated with a fluorescent dyepenetrant and viewed in ultra violet light). During the test, ‘‘marker’’ loads were applied occasionally to produce bench marks on the fracture surfaces.

These bench marks provided a record of the actual shape of the crack front during crack propagation and also served to verify the visual crack length measurements made during the test. The compressor disks were tested on a special hydraulic test bed. Loading was brought to bear on the blade roots by coupled hydraulic power cylinders. The general characteristics of the radial and tangential stress distribution on this test bed are like those for the rotating disk in real operation. All aspects of the tests concerning the features of multiaxial disk loading and test bed construction are described

Conclusion based on Inconel alloy

By studying all those papers we concluded that these Inconel alloys are mainly used in aerospace applications .And these alloys are corrosion resistant, Inconel retains high strength over a wide range of temperature applications. And these Inconel alloys temperature strength is developed by solid solution strengthening. And for finding hardness using Vickers hardness testing machine and for microstructure scanning electron microscope and other equipments are used.

So now in this study we came to know that by various methods are used for testing. So in my view with the two these two reinforcement of materials can be done by using one of the methods

3. Powder Metallurgy Technique

The powder metallurgy press and sinter process generally consists of three basic steps: powder blending (pulverisation), die compaction, and sintering. Compaction is generally performed at room temperature, and the elevated-temperature process of sintering is usually conducted at atmospheric pressure and under carefully controlled atmosphere composition. Optional secondary processing such as coining or heat treatment often follows to obtain special properties or enhanced precision

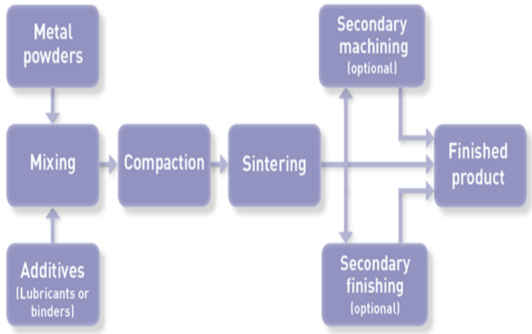

Fig. 3: Powder Metallurgy Process

Principles of Powder Metallurgy

The long-established powder metallurgy process involves the blending of the metal powders and other constituents by compaction and sintering to obtain desired size and shape. The two stages of compaction are fused into a single step in hot pressing. Some of the problems occurred during die-compaction and compaction of sintering in traditional powder metallurgy technique can be overcome by newly developed isostatic compaction method.

Materials and Processes in Powder Metallurgy

- Titanium: - Hot Isostatic pressing (HIP), Injection moulding.
- Super alloy and steel: - Spray Forming.
- Aluminide, Nickel: - Reaction sintering and Extrusion.
- Iron alloy: - Powder Forging.
- Stainless steel: - Cold isostatic pressing (CIP).
- Solidified aluminum alloy:- Complete densification method

Applications of Powder Metallurgy

- Gears, bearings and connecting rods (for automobiles)
- Produce cutting/abrasion resistant tooling materials such as cemented carbide tip and moulding
- Porous materials such as filters and implants for living bodies
- Materials for pantograph contact strips
- Sensor rings
- Aircraft structuring
- Fine jewellery/accessories
- Cutting Tools and Dies
- Anticorrosive component
- Dynamic membranel filter

Literature Review on Powder metallurgy technique

Review on Processing Techniques applied in Powder Metallurgy:

Author: **Najlaa Nazihah Mas'ood (2018)**

Processing two materials which have different properties gives significant impact to the industries due to their amazing properties which leads in improving the functionality and reliability of products. Many materials have been investigated in terms of layering, bi-material and also co-injection molding process. The two materials may be metal-metal, ceramic-ceramic and metal-ceramic depending on the capabilities requirement. Several techniques have been discussed in this paper regarding improving the hardness properties, magnetic/nonmagnetic and many more.

This paper focused on reviewing the methods that were implemented by researchers based on the bonding techniques of two materials. However, both combination metal-metal and metal-ceramic are the most challenging due to their different properties in terms of thermal expansion. For example, in order to control the coefficient thermal expansion (CTE) for each material, before implementing the required process, dilatometer studies are needed. Such study provides an overview on how to suit the diffusion mechanism between the two materials.

Review on Recent Advancements in Powder Metallurgy:

Author: **Shagil Akhtar (2018)**

An overview in the advancements of Powder Metallurgy has been studied in this paper. The investigations are focused upon the mechanical properties of sintered structure along with its advantages and limitations. The recent methods like nanocrystalline materials, intermetallic and composites have also been studied considering its applications.

Review on Joining processes for Powder Metallurgy Parts:

Author: **Cem Selcuk, Stuart Bond (2010)**

Powder metallurgy (PM) processes have high productivity and are ideal for making near net-shape parts of complex geometries from a range of materials, which maximizes material utilization, and minimizes or eliminates secondary operations such as machining. The secondary operations that are common for components made via liquid metal processing may result in additional manufacturing steps with substantial cost and waste implications.

Despite this obvious advantage of PM components, including powder metal injection moulded (MIM) parts, the joining of sintered powder materials has been associated with difficulties related to their inherent characteristics, such as porosity, contamination and inclusions, at levels which tend to influence the properties of a welded joint.

A critical review of the current state of the art of welding PM components is presented. The intention is to identify preferred joining processes and identify technology gaps in joining of PM parts, in terms of initial processing and attendant materials issues, with an emphasis on offering solutions to welding problems. Brazing, diffusion bonding and shrink fitting are briefly considered in addition to welding.

Review on Powder Metallurgy: Advanced Techniques and Applications:

Author: **Akanksha Verma (2018)**

In this paper, a brief review about the advancement in powder metallurgy process along with their applications as well as problems faced during the research is discussed. The main objective of this paper is to accentuate the applications of advanced powder metallurgy technology in various fields and also to encourage the readers to understand and write more papers on such issues.

Advanced Powder Metallurgy is also known as metal injection moulding (MIM) technology helpful for forging complex shaped components with a low investment of money. Therefore, a forming technology applied to form new materials by diffusion of different metals as well as ceramic powders as raw ingredients through sintering (temperature below the melting point) is known as powder metallurgy.

The most advantageous thing of this process is that the powder can easily be shaped directly into the end product and also possesses a significant degree of freedom in the composition of materials, properties, microstructure and thermal processing. Powder Metallurgy provides such properties that cannot be achieved by the melting process. Advancement in Powder Metallurgy technique is a standard allusion for the engineers in the metal forming industries that use powder metallurgy with a research interest in the field.

Review on Micro and Nano Fabrication by Powder Metallurgy:

Author: **Angelo PC (2015)**

Powder Metallurgy (P/M) is recognized today as one of the most important near net shape fabrication techniques for manufacturing several industrial products. Recent advances in aerospace, automotive, bio-engineering, communications, computers and medical fields call for miniaturized components of complex shapes in metals and plastics due to the increasing demands for precision engineered components and systems.

P/M process is well suited for manufacturing small and tiny components in large numbers especially by Powder Injection Moulding, an off-shoot of plastic injection moulding. In addition, other fabrication techniques such as, Micro powder injection moulding (μ PIM), Semisolid Powder Processing(SPP), Low pressure injection moulding (LPIM), Nano powder injection moulding (NPIM), Rapid Prototyping(RPT), Micro sacrificial plastic mould insert PIM (μ-SPiPIM), Copowder injection moulding (2C-PIM), Selective Laser Sintering(SLS), Selective Laser Melting(SLM), Laser Micro Sintering(LMS), Electron Beam Melting(EBM) and Nano Forging by FIB/SEM have been adopted to fabricate micro and nano sized components.

Conclusion

After studying some of the research papers, in the end, we come to the conclusion that, in recent, metal injection moulding (MIM) and powder lamination 3-D printing are brought as new powder forming techniques. Producing large products is still difficult because of deformation due to their own weight during the debinding process and long processing time. If these problems are resolved then the scope of application is expected to be greatly expanded. Contrarily, metallic powder lamination 3D printing has just come into the trend with the efficiency of forming complicated structures and shapes on the outer as well as the inner side. The roughness of the side surfaces and entire dimensional accuracy need to be improved.

4. Overall Conclusions:

So based on various studies of some of reviews on Inconel-825, Al-7075 and Powder Metallurgy Process

We came to know that the experimentation using the process with these materials is seen and it can be done for the particular required composition to get various inputs based on working conditions. Some of the problems are occurred with the volume production.

But for powder metallurgy technique is different and unique from a manufacturing point of view. Now, at last, based on the whole study the further advancement and development is needed to be very much upgraded.

So the aluminium powder metallurgy (PM) for high-strength applications was undertaken. Improvements in aluminium—base alloys made via ingot metallurgy (IM) are reaching the point of diminishing returns. PM offers an alternative technology, capable of producing alloys having improved fatigue, corrosion, and stress-corrosion resistance, as well as improved strength and toughness at room or elevated temperatures. The steps involved in powder metallurgy: powder manufacture, powder processing, de-gassing, and consolidation, are described. The merits and deficiencies of the various processes for each step are compared. The key to successful application of Al powder metallurgy alloys appears to be the de-gassing and consolidation of the powder. The properties of several new PM alloys are compared, with particular emphasis on high strength, corrosion-resistant alloys and alloys developed for use at elevated temperatures

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