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Enhancing Machinability in the Heat Treatment of Inconel 718: A Comprehensive Review

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Abstract

The increasing need for materials with high strength and heat resistance, particularly in aerospace applications, creates machining issues. These materials are generally difficult to machine because to their strong wear resistance, abrasion resistance, and low heat conductivity. This produces strong cutting forces and temperatures, resulting in a limited tool life. variances in the microstructures of various materials can induce variations in machinability due to variances in chemical composition, casting, forging processes, and heat treatments. Different heat treatments are applied to the alloy Inconel 718, which has an austenitic matrix with a unique microstructure containing the γ matrix, γ' precipitates, γ'' precipitates, δ precipitates and carbides. Using annealing processes at various heating temperatures and cooling rates can improve machinability and tool life. Annealing heats the metal above its critical temperature and then cools it slowly over time in a medium. The adhesion and hardness properties of Inconel 718 contribute to short tool life. Careful evaluation of elemental distribution, grain morphology, and texture using analysis methods like TEM, SEM, EDS, and OM provides understanding of the built material's properties. In summary, heat treatments like annealing can help overcome the machining challenges of high-strength, heat-resistant alloys like Inconel 718 by optimizing their microstructure.

Keywords: Heat Treatment, Inconel 718, microstructure, *Tool wear,* material's properties

INTRODUCTION

Inconel 718 is a heavy-duty alloy that is primarily utilised in the fabrication of aviation engine components. It has strong mechanical qualities at cryogenic, moderate, and raised temperatures, but low thermal conductivity [5–13]. Since the 1960s, Inconel 718 has been used extensively in aviation turbine engines, rocket motors, and, more recently, nuclear reactors. By 1966, it was one of the most heavily manufactured alloys, with more than one million pounds utilised in aviation and other engines. However, Inconel 718 is difficult to mill because the cutting tools wear out quickly during the machining process. Selecting suitable cutting settings is critical for specific machining operations. The high hardness, thermal stability, adhesion to cutting tools, and workpiece make Inconel 718, a nickel-based superalloy, challenging to cut or machine. The same properties that make it an important structural material also lead to poor machinability [55, 58]. The Inconel 718 microstructure consists of a γ solid solution matrix rich in Ni, Cr, and Fe, along with γ' precipitates, γ'' precipitates, and δ phase particles. The γ' and γ'' provide strengthening while the δ phase controls grain size at boundaries. Key factors determining machinability include workpiece hardness, cutting forces, surface finish, and tool life. In summary, Inconel 718's properties provide strength at high temperatures but also make it difficult to machine, requiring optimized machining parameters (Table 1).

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Table 1. Composition of Inconel 718.

	Ni	Fe	Cr	Nb	Ti	Mo	Al	Co	C	Mn	P	Si
Min	56.00	--	21.01	5.56	1.18	3.31	0.81	1.1	0.09	0.4	0.01	0.3
Max	50.1		17.00	4.89	0.62	2.81	0.22					

LITERATURE REVIEW

Tool Wear

Mall et al. [1] found that Inconel 718 has a significant tensile residual stress after machining, which reduces machinability by resulting in poor surface quality. They discovered that optimising surface roughness necessitates modifications to cutting depth, feed rate, and cutting speed, as well as the usage of a certain nose radius for the cutting tool. Carbide tools, despite producing excellent surface quality, have a limited capacity to withstand deep cutting depths and are primarily utilised for light-duty machining, turning, and finishing tasks. Rahman et al. [2] found flank wear, surface roughness, and cutting forces as important markers of tool lifetime performance. They examined two types of inserts on a CNC lathe machine: physical vapour deposition and chemical vapour deposition. They discovered that raising the secondary edge clearance angle extended tool life, whereas decreasing it reduced tool life. Furthermore, greater speed or feed resulted in shorter tool life due to variables such as strong cutting pressures and low heat conductivity. Bushlya et al. [3] discussed the difficulties in machining nickel-iron based alloys such as Inconel 718 owing to its mechanical and thermal characteristics. Traditional carbide tools perform poorly at lower cutting speeds and must be modified or replaced with PCBN tools to get better performance at higher cutting speeds.

Eren and Birol [4] explored the complicated interactions that cause tool wear during the machining of nickel-based alloys. They found wear patterns such as expansion and adhesive wear, as well as investigated how tool nose radius affects mechanical parameters such as residual stresses and surface roughness. Addona et al. [9] investigated turning operations with coated carbide inserts and discovered that tool wear rates varied with cutting speed. Coated carbide inserts performed better at certain temperatures, with greater cutting speeds resulting in quicker wear rates and bigger patterns of tool failure. Pande and Sambhe [10] found that carbide tips performed poorly at high cutting speeds on Inconel 718, with uncoated carbide tips outperforming coated tips due to disturbances in surface integrity. They discovered that increased surface finishing was possible within a specified cutting speed range, and that tool life varied according to secondary clearance edge angle and cutting speed. Xavior et al. [11] examined the wear behaviour of TiAlN carbide, CBN, and ceramic tips when turning Inconel 718. They discovered that ceramic and CBN tool wear reduced as cutting speed increased, but carbide tool wear declined at lower speeds. Altin et al. [37] studied the wear rate of ceramic tips at various cutting speeds and discovered four forms of wear, with greater cutting speeds yielding the longest tool life.

Microstructure

Tucho et al. [12] emphasise the need of post-treatment processes in achieving the necessary conditions and qualities for components manufactured utilising selective laser melting technique with alloy 718. These components have higher initial hardness values than those made using typical wrought processes. Post-treatments, including pre-aging treatments tested at temperatures of 1100°C or 1250°C, are critical for determining the impact on microstructure, hardening characteristics, and micro segregation. Compared to heat-treated samples, printed samples are more complicated because to the repeated heating and cooling cycles used during fabrication. Solution heat treatment at 1200°C completely dissolves precipitates and other phases at subgrain boundaries. Additionally, recrystallization during the solution treatment causes grain coarsening effects. Bacaltchuk et al. [13] investigate the magnetic behaviour of thick silicon (GNO) flat material, which is principally affected by two microstructural factors: final texture and average grain size. Energy, mobility, and anisotropy in energy caused by grain boundary migration during recovery, grain mobility, and grain development all have an impact on form, or crystalline preference. The application of structural flexibility and natural

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exposure to ferrous alloys has a major impact on magnetic field strength. Samples subjected to the maximum magnetic field intensity employed, 8 Tesla, are positioned to maximise their impact in texture enhancement.

Kishan et al. [20] elaborate on the degree of stabilization contingent upon the distribution of γ' and γ” phases within the γ matrix. The strengthening of γ” is facilitated by Ni3Nb at 720°C, while γ' is reinforced by Ni3 combined with Al or Ti at 620°C, and δ NbC at 650°C. These phases contribute to stability, whereas γ” transforms into the delta phase at high temperatures, consequently reducing material hardness. The delta phase impedes grain mobility and grain growth, thereby influencing material properties.

Grain Size

Mukhtarova et al. [56] discovered that superalloy Inconel 718 manufactured using selective laser melting (SLM) procedures had higher gamma size and dislocation diffusion than ordinary materials. Increased torsion pressure during superalloy manufacturing resulted in microstructure refinement and increased microhardness in both alloys. Annealing the deformed superalloy at 600°C for two hours resulted in enhanced microhardness. Selective laser melting techniques showed higher microhardness than traditional approaches, showing its applicability for applications requiring hard materials.

ZHANG et al. [21] studied the microstructure and tensile behaviour of superalloy K4169 at various rates of undercooling. Increased rates of undercooling caused changes in dendritic morphology, intergranular phase distribution, and grain size. At higher undercooling levels, a consistent distribution of the Laves phase was found, resulting in better strength and mechanical characteristics. Emphasised the importance of Inconel 718 in the defence industry because to its remarkable mechanical strength [14]. The strength of the NS state of Inconel 718 alloy varied with grain size, with smaller grain sizes demonstrating greater strength, reaching up to 1920 MPa at room temperature. They emphasised the need of using the NS state of Inconel 718 after heat treatment to obtain both high strength and appropriate ductility, highlighting the need for enhanced heat-treatment procedures to maintain the lifespan of these alloys. Investigated grain size effects in Inconel 718 samples that had been heat-treated at various temperatures [15]. They found that increased grain size led to decreased hardness and tensile properties, negatively impacting creep life improvement. Small grain sizes were associated with lower ductility at room temperature. Complete dissolution of γ' and partial dissolution of γ” phases in Inconel 718 occurred through solution heat treatment at around 1050°C for two hours. Additionally, the delta phase formed within the matrix at the same temperature, with δ phase observed along grain boundaries at 960°C, contributing to reduced ductility with increased grain size. Therefore, achieving better strength requires maintaining a small grain size.

Hardness

Hernandez et al. [23] investigated the poor machinability and reduced tool life of Inconel 718, attributing these challenges to the presence of precipitated phases such as γ', γ”, and δ, which contribute to its high hardness. They observed carbide formation within a temperature range of 600 to 670°C and noted that samples strengthened within the temperature range of 600 to 648°C exhibited rapid growth of γ” phases, resulting in a maximum hardness value of 360 HV. The material underwent phase transitions between 760 and 820°C, with a drop in hardness to 230 HV recorded at 900°C. Material shrinkage occurred between 820 and 950°C, suggesting the creation of the delta phase, which has greater hardness values. MAJ et al. [24] investigated the tensile and hardness parameters of Inconel 718 after heating and soaking it at various temperatures for varying times. They discovered a functional link between initial ageing and reheating temperatures ranging from 650°C to 900°C for periods of 5 to 480 minutes. Changes in microstructure at different stages of strength were influenced by these factors, with the highest strength observed in the temperature range of 650 to 750°C, where the γ" phase primarily nucleated homogeneously. At temperatures of 850°C and above, phases were found to form heterogeneously, resulting in material weakening with longer annealing times, particularly evident at 800°C.

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Schirra [25] explored the benefits of improved heat treatment procedures for increasing desirable characteristics while decreasing hardness levels and cycle durations. Their findings revealed a 7RC reduction in hardness levels as well as a 30% reduction in heat treatment cycle time. Controlled cooling rates, higher heating temperatures, and longer homogenization cycle periods were used to modify the process. They discovered that precipitation periods were shorter with greater solution times and longer with lower solution times, highlighting the importance of solution time in the heat treatment process.

Heat Treatment

Kuo et al. [29] investigated the effect of ageing time on the distribution of delta phase at grain boundaries in Inconel 718. They discovered that the delta phase increased consistently with increased ageing time. Energy Dispersive X-ray Spectroscopy (EDS) study indicated that the delta phase included NbC, which stayed at grain boundaries and controlled grain mobility and growth. Grain sizes of 170 µm, 160 µm, and 155 µm were produced by three distinct heat treatment techniques. The delta phase remained stable after ageing at 955°C but exhibited variations between 650°C and 980°C. Sui et al. [53] studied the change of Laves phases in laser-assisted melted Inconel 718 at different temperatures and times. They observed a change from long-striped to granular shape at 1050°C for 15 minutes, with a subsequent decrease in volume fraction at 1050°C for 45 minutes. Niobium micro-segregation influenced Laves phase formation, leading to coarsening and an uneven distribution of the γ” phase. Heating at 1050°C for 15 minutes eliminated long-striped Laves phases and promoted uniform γ” phase distribution.

Ghosh et al. [54] used a ball indentation technique combined with optical microscopy to evaluate the strength of Inconel 718 specimens exposed to various heat treatment techniques. They discovered that specimens were heated at 940°C for one hour, water quenched, then aged at 720°C for 8 hours had better strength than other heat-treated specimens. Strength dropped with solution treatment but improved with age. Anbarasan et al. [30] covered common heat treatment techniques for Inconel 718, such as homogenization, solution annealing, and precipitation hardening. They noted that furnace cooling improved hardness due to precipitation strengthening of both γ' and γ” phases. However, ice brine quenching resulted in lower hardness due to the absence of precipitation. At high temperatures, the gamma double prime phase of Inconel 718 transforms into the stable delta phase [23]. They discovered that the delta phase, while undesirable in high quantities, stayed near grain borders, impeding grain expansion. Increased numbers of delta phase particles resulted in lower hardness ratings.

Sui et al. [63] investigated the tensile behaviour of Inconel 718 under various heat treatment regimens following laser metal deposition. They discovered changes in grain structure between two types of treatments, with one type having more recrystallization than the other. Hall and Beuhring [48] investigated various solution treatments for forming processes, emphasising the need of balancing temperature concerns for metal softening and grain size management. They recommended rapid cooling for thick sections and spray quenching for thin sections to achieve uniform softness. Additionally, they highlighted the importance of high-temperature heating followed by slow cooling to improve ductility and reduce hardness in nickel-based superalloys [25].

Heat Treatment and Magnetic Field

Patwari et al. [70] evaluated the use of a magnetic field during the turning process on annealed mild steel and discovered that both heat treatment and the magnetic field helped to reduce hardness and enhance machinability. The utilisation of a magnetic field while turning on an annealed specimen improved surface quality, chip continuity, and decreased adhesion, resulting in longer tool life. Li et al. [49] investigated the effects of a constant magnetic field during heat treatment on superalloy DZ483, concentrating on mechanical behaviour and microstructure. They discovered that a consistent magnetic field reduced precipitate grain coarsening and alloy diffusivity, resulting in delayed splitting and smaller average precipitate sizes. A smaller size of γ' precipitates indicated improved tensile strength with the use of a magnetic field during heat treatment. Li et al. [50] further investigated the impact of an

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alternating magnetic field (AMF) during heat treatment on DZ483 superalloy, specifically studying segregation and microstructure evolution. They found that the AMF accelerated morphology transition, reduced segregation, and increased the average particle size of γ' precipitates. Compared to treatments without a magnetic field, using an AMF during ageing treatments resulted in bigger average precipitate particle sizes. [29] investigated the effects of a magnetic field applied during cooling on nickel-containing alloys (65% permalloy and 20% perminvar). They detected changes in magnetic characteristics at temperatures near 500°C due to local material rearrangement, which relieved magnetostrictive stresses. The most significant impacts were detected between 400°C and 500°C.

Zhang et al. [21] studied the quenching of 42CrMo structural steel, both with and without a magnetic field. They discovered that the magnetic field hindered directed cementite development at martensite plate borders, resulting in the production of particle-like cementite structures. Ludtka et al. [22] investigated the effects of a magnetic field on the heat treatment of medium carbon steel, finding enhanced latent heat liberation and austenite breakdown rates. They discovered that the magnetic field enhanced the volume percentage of ferrite and converted pearlite to ferrite with no coarsening effects on the microstructure. [32] investigated the use of an alternating magnetic field during solidification to minimise flaws in Cu-14Fe alloys. They discovered that the magnetic field influenced the nucleation of loose grains and fusing dendrites, resulting in effective grain refining. Molodov et al. [57] explored the use of a magnetic field to inhibit grain boundary motion and grain coarsening, noting anisotropy in magnetic susceptibility and its influence on texture and microstructure evolution in cold-rolled zinc-aluminum. Dong et al. [62] used a strong static magnetic field during heat treatment of alloy 2024, resulting in greater dissolution of secondary phases into the -Al matrix and better mechanical characteristics [31].

MICROSTRUCTURE STUDY AND MECHANICALTESTING

Based on the information supplied, it appears that you are describing a review article on different elements of materials science and machining processes, with a particular emphasis on microstructure, tool wear, grain size, phase segregation, and precipitation [33-38]. The review paper is likely to discuss several characterisation techniques used to analyse these properties, such as Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Optical Microscopy (OM), and High-Resolution Photography. These approaches are expected to be thoroughly explored in the review article, perhaps including a full comparison of their strengths, limits, and applications in the research of microstructural characteristics and machining parameters [19]. It is also said that Table 2 of the review article contains these strategies and their accompanying information, presumably including their applicability in specific research cited in the publication [39-42]. The reference numbers listed in the study are most likely the same as the serial numbers in the reference list at the conclusion of the review paper. In addition, the articles cited in the study are likely to offer brief summaries of the parameters evaluated utilising these methodologies [43-45]. Overall, the review article looks to give a thorough overview and analysis of numerous characterisation approaches employed in materials science research, particularly when investigating microstructure and machining parameters [26-28].

Inconel 718's properties will be characterised using several hardness testing methods, including the Rockwell, Brinell, and Vickers tests. For the property analysis of Inconel 718, tensile or compression tests are performed in accordance with various standards, as shown in Table 2. Table 3 provides a full list of several test parameters, together with their ASTM testing standards and descriptions of the qualities evaluated in the mentioned reviewed sources [46-52].

FLOWCHART

The flow chart (Figure 1) depicts the relationship between machinability, heat treatment, magnetic field, microstructure, response parameters, process parameters, and the control factor [59-63]. This contributes to a better understanding of how to increase machinability and regulate microstructure, or all phases of Inconel 718, using heat treatment and a magnetic field.

Table 2. Microstructure study of phases and structure.

Ref. No.	Abbreviation of Test	Full form	Description
3,4,5,6,8,9,12,13,15,16,18,19, 20,21,22,23,24,27,28,30,32,33, 34.	SEM	Scanning Electron Microscopy	Grain Size, tool wear morphology, and texture of materials, the 3D image of the surface of the sample, Resolution: 50 nm-100 nm.
9,12,13,14,17,24,30,32,	TEM	Transmission Electron Microscopy	Size, morphology, and texture of materials, intergranular phase,2D projections of the sample, Resolution: 0.2 nm-10 nm.
9,19,22,27,28,34	EDS	Energy Dispersive X-Ray Spectroscopy	Crystal system of material, compound phases Characterization of the sample
3,4,9,22,32,34,	XRD	X-ray diffraction	Tool wear analysis microstructure area scan and spot scan Resolution: 11 nm- 13 nm.
7,8,13,14,15,22,24,26	OM	Optical Microscope	Tool wear, chip morphology analysis, surface roughness comparison, fracture, grain size measurement morphology - and texture materials, Resolution: 0.2 µm-0.7 µm.
5	HRP	High-Resolution Photography	Tool wear analysis-

Table 3. Mechanical testing.

Ref. No.	Abbreviation of Test	Full form	Description
7,9,12,16,17,13, 15,18,21,22,30	Hardness (Rockwell, Brinell, Vickers)	ASTM E18-79, ASTM E-384, ASTM E384, EN ISO 6507, ASTM E-92	Force applied, Indentation area, and depth of penetration decides Micro or Macro hardness.
13,20,21,30	Tension or compression	ASTM.E8, ASTM E8-95, E9-95, ASTM B557 M94, ASTM E8M-15a	Tensile or compressive strength, stress, strain, and other properties.
13,15,19,20	Other properties	-	Yield modulus, Ductility, density, fracture toughness, creep, etc.

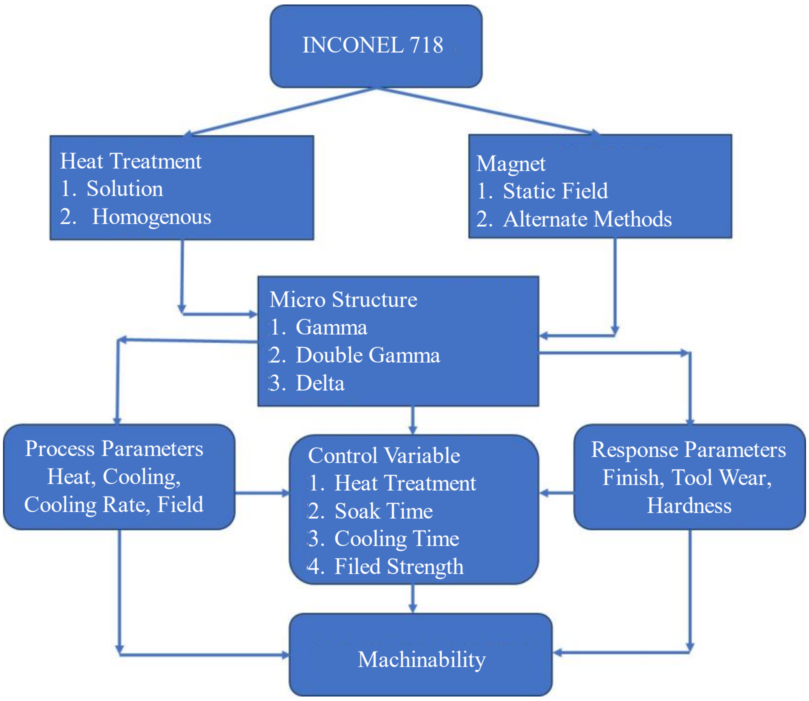

Figure 1. Magnetic Field and Heat treatment Process Flow Chart.

DISCUSSION

Machining Inconel 718 has issues such as tensile residual stress, short tool life, and high cutting

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pressures due to its hard surface. Various cutting tools are used for different processes, but no one tool can effectively meet all machining needs. The hard surface of Inconel 718 requires a soft surface layer for ease of machining, higher surface polish, and longer tool life. The toughness of this alloy is attributable to two precipitation phases inside the gamma matrix: gamma prime and gamma double prime. During cutting, insufficient heat transmission causes excessive heat buildup, resulting in tool adhesion and material hardening. Carbide tools are best suited for medium cuts and finishing operations because they produce the appropriate surface polish [64-66]. However, they are unsuitable for severe cutting duties owing to wear at high speeds. Coated cutting tips do not operate well under high temperatures or intensive cutting conditions. At high temperatures, the major strengthening phase, gamma double prime, converts into stable delta particles, which inhibits grain boundary movement and development. Higher concentrations of delta particles diminish material hardness, whereas smaller grain sizes enhance strength but have reduced ductility at room temperature [67-68]. Solution treatment at 1050°C causes full dissolution of gamma prime particles and an increase in delta particles, resulting in reduced hardness.

Experimental studies reveal that using a high magnetic field during heat treatment can reduce hardness and increase toughness by encouraging texture development and grain orientation. Large grain sizes influence gamma double prime phase distribution, resulting in inhomogeneous grains due to the existence of Laves phases [69-73]. To convert long strip Laves phases into granular forms, heat them at 1050°C for 15 to 20 minutes. To address the issues given by high temperatures during solution treatment, experimental experiments using various magnetic fields are required to avoid grain size growth and adjust texture and grain orientation. Machining trials with annealed mild steel in a magnetic field revealed less adhesion, greater surface smoothness, longer tool life, and continuous chip flow. Magnetic fields have been observed to alter precipitation and grain coarsening following heat treatment in the DZ483 superalloy [74-77]. Static magnetic fields diminish grain coarsening, but alternating magnetic fields reduce microsegregation, increase particle size, and reduce gas hole defects. Heating medium carbon steel with a 30T magnetic ferild at approximately 800°C and varying cooling rates causes austenite decomposition, increased ferrite volume percentage, improved pearlite to ferrite transformation, and reduced coarsening, demonstrating the potential benefits of magnetic field-assisted heat treatments.

CONCLUSION

Machining Inconel 718 reduces tool life and generates excessive heat due to the alloy's strong cutting forces, low thermal conductivity, inclination to adhere, and work harden (EH20Z-UP and AC25 grades). Increasing the cutting speed, feed rate, or depth of cut further reduces tool life. The precipitate phases γ', γ'', and δ in Inconel 718 contribute to its hardness. A small proportion of δ phase at grain boundaries does not affect hardness, but increased δ phase can reduce hardness by impeding grain interiors. At high temperatures, the metastable γ'' converts to stable δ phase of NbC composition, restricting grain growth and mobility. Using magnetic fields during heat treatment can improve the microstructure and characteristics. Using regulated heating, soaking, and cooling cycles with varying magnetic field strengths aids in the development of the appropriate Inconel 718 characteristics and strength. In summary, Inconel 718's phases impact its hardness and machinability, whilst heat treatments with magnetic fields allow for microstructure modification to modify its qualities.

REFERENCES

1. Mall V, Kumar P, and Singh B 2014 A Review of Optimization of Surface Roughness of Inconel 718 in End Milling using the Taguchi Method Int. Journal of Engineering Research and Applications.4103-109.
2. Rahman M, Seah W K H, and Teo T T 1997 The Machinability ofIncone1 718 Journal of Materials Processing Technology. 63199-204.
3. Bushlya V, Zhou J, and Stahl J E 2012 Effect of Cutting Conditions on Machinability of Superalloy Inconel 718 During High Speed Turning with Coated and Uncoated PCBN Tools 45th CIRP Conf.

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on Manufacturing Systems.3 370-75.
4. Kaya E, and Akyuz B 2017 Effects of cutting parameters on machinability characteristics of Ni-based superalloys: a review Open Eng.7 330–42.
5. Sollapur, S.B., Sharath, P.C., Waghmare, P. (2024). Applications of Additive Manufacturing in Biomedical and Sports Industry. In: Rajendrachari, S. (eds) Practical Implementations of Additive Manufacturing Technologies. Materials Horizons: From Nature to Nanomaterials. Springer, Singapore. https://doi.org/10.1007/978-981-99-5949-5_13
6. Chate, Ganesh R., et al. "Ceramic material coatings: emerging future applications." Advanced Ceramic Coatings for Emerging Applications. Elsevier, 2023. 3-17. https://doi.org/10.1016/B978-0-323-99624-2.00007-3
7. Pankaj G. Bedmutha, Pratik M. Waghmare, Shrishail B.Sollapur "MECHANICAL PROPERTIES OF BAMBOO FIBER REINFORCED PLASTICS" Internation Journal for Science and Advance Research In Technology, 3(9),(2017), pp 365-368
8. Sollapur, S., Patil, M.S., Chaporkar, K., Misal, A., Bhoyar, R., Dhole, K. (2020). Design and Development of Constrain Based XY Flexural Mechanism. In: Pawar, P., Ronge, B., Balasubramaniam, R., Vibhute, A., Apte, S. (eds) Techno-Societal 2018. Springer, Cham. https://doi.org/10.1007/978-3-030-16962-6_27
9. Addona D M D, Raykar S J, and Narke M M2017 High-speed machining of Inconel 718: tool wear and surface roughness analysis 10th CIRP Conf. on Intelligent Computation in Manufacturing Engineering. 62 269-74.
10. Pande P P, and Sambhe R U 2014 machinability assessment in turning of Inconel 718 nickel-base superalloys: a review International Journal of Mechanical Engineering andTechnology.5 94-105
11. XaviorM A, Patil M, Maiti A, Raj M, and Lohia N 2016 Machinability studies on Inconel 718 IOP Conf. Series: Materials Science and Engineering.149 012019.
12. Tucho W M, Cuvillier P, Kverneland A S, and Hansen V 2017 Microstructure, and hardness studies of Inconel 718 manufactured by selective laser melting before and after solution heat treatment Materials Science & Engineering A.689 220-32.
13. Bacaltchuk C B M, Castello-Branco G A, Ebrahimi M, Garmestani H, and Rollett A D 2003Effect of the magnetic field applied during secondary annealing on texture and grain size of silicon steel Scripta Materialia.48 1343–47.
14. Waghmare, Pratik M., Shrishail B. Sollapur, and Shweta M. Wange. "Concrete Solar Collector." Advances in Smart Grid and Renewable Energy: Proceedings of ETAEERE-2016. Springer Singapore, 2018. https://doi.org/10.1007/978-981-10-4286-7_46
15. Vinod, M., Kumar, C.A., Sollapur, S.B. et al. Study on Fabrication and Mechanical Performance of Flax Fibre-Reinforced Aluminium 6082 Laminates. J. Inst. Eng. India Ser. D (2023). https://doi.org/10.1007/s40033-023-00605-4
16. Raut, P.P., Rao, A.S., Sollapur, S. et al. Investigation on the development and building of a voice coil actuator-driven XY micro-motion stage with dual-range capabilities. Int J Interact Des Manuf (2023). https://doi.org/10.1007/s12008-023-01665-2.
17. Swapnil S. Shinde, Shrishail B Sollapur, "Effect of Residual Stress on the Mechanical Behavior of AISI 304, For TIG Welding", International Journal of Scientific & Engineering Research Volume 8, Issue 10, October-2017.
18. Venkate Gowda, C., Nagaraja, T.K., Yogesha, K.B. et al. Study on Structural Behavior of HVOF-Sprayed NiCr/Mo Coating. J. Inst. Eng. India Ser. D (2024).
19. Devakant Baviskar Shrishail Sollapur, Dr Mahesh M Kawade, Prasanna Raut, "An ANN Approach to Determine the Surface Roughness in End Milling Cutter", International Journal of Research Publication and Reviews(2024), Vol 1, issue5, page 4360-4365.
20. Kishan E V R, and Nagarajan N M 2015 Strengthening of Forged Inconel Superalloy by Age Hardening Heat Treatment International Journal of Innovative Science, Engineering & Technology.2387- 91.
21. Zhang Y, Gey N,He C, Zhao X, Zuo L ans Esling C 2004 High-temperature tempering behaviors in structural steel under a high magnetic fieldActa Materialia.523467-74.

Galley Proof for Author's Review and Approval Only.

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22. Ludtka G M, Jaramillo R A, Kisner R A, Nicholson D M, Wilgen J B, G,Ludtka G M,and Kalu P N 2004 In situ evidence of enhanced transformation kinetics in medium carbon steel due to a high magneticfield Scripta Materialia.51 171–74.
23. Hernandez A M, Santoyo-Arreguin M T, Vazquez-Gomez O and Herrera Ramirez J M 2017 Microstructural Characterization of Inconel 718 for Aeronautical Use *Microscopy Society of America.*23788-89.
24. Maj P, Adamczyk-Cieslak B, Slesik M,Mizera J, Pieja T, SieniawskiJ, Gancarczyk T, and Dudek S 2017 The precipitate on processes and mechanical properties of aged Inconel 718 alloy after annealing*Arch. Metall. Mater.*62 1695-1702.
25. Schirra J J,1997 Development of an Improved Heat Treatment for Investment Cast Inconel718 *United technology corporation.*PWA-649.
26. Gireesh, Belawagi, B. Sollapur Shrishail, and V. N. Satwik. “Finite element & experimental investigation of composite torsion shaft.” Int. J. Engg. Research and Applications 3.2 (2013): 1510-1517.
27. Deore, O. B., & Sollapur, S. (2020). Design and Analysis of Complaint Mechanism using FEA. International Journal of Modern Trends in Engineering and Research (IJMTER), 7(10). DOI:10.21884/IJMTER.2020.7059.BWQR6
28. Sollapur, Shrishail B., M. S. Patil, and S. P. Deshmukh. “Design and development aspects of flexure mechanism for high precision application.” AIP Conference Proceedings. Vol. 1943. No. 1. AIP Publishing, 2018. https://doi.org/10.1063/1.5029599
29. Kuo C M,Yang Y T, Bor H Y, Wei C N, and Tai C C 2009 Aging effects on the microstructure and creepbehaviorofInconel718 superalloy *Materials Science and Engineering A.*510–511 289-294.
30. Anbarasan N, Gupta B, Prakash S, Muthukumar P Oyyaravelu R, Felix J, and R, JeromeS, Effect of Heat Treatment on the Microstructure and Mechanical Properties of Inconel 718*Materials Today: Proceedings.*5 7716-24.
31. Pratik Waghmare, “Development and Performance Investigation of Solar Concrete Collector at Different Climatic Conditions”, *Indian Journal of Engineering and Materials Sciences,* https://doi.org/10.56042/ijems.v30i2.1384
32. Prasanna Raut et. Al, “Design and Testing of Flexural Kinematic Mechanism using Large Workspace”, Eur. Chem. Bull. 2022, 11(Issue 12), 213-221, DOI: 10.48047/ecb/2022.11.12.025
33. Devkant Bhaviskar et.al, “Design of XY Planer Mechanism using DFM for Parallel-Kinematic Micro Positioning XY Stage”, Stage Eur. Chem. Bull. 2022,11. (Issue 11), 222-228 DOI: 10.48047/ecb/2022.11.11.25
34. Shrishail Sollapur, Pratik Waghmare, “Design and Experimental Investigation of XY Compliant Mechanism for Precision Applications”, ECS Transactions, 2022/4/24, Volume 107 Issue 1 Pages 4967. DOI 10.1149/10701.4967ecst
35. Shrishail Sollapur, Saravanan, D., et al. “Tribological properties of filler and green filler reinforced polymer composites.” Materials Today: Proceedings 50 (2022): 2065-2072. https://doi.org/10.1016/j.matpr.2021.09.414
36. SOLLAPUR, S. B., WAGHMARE, P. M., PATIL, M., & DESHMUKH, S. (2021). DESIGN AND EXPERIMENTAL TESTING OF XY FLEXURE MECHANISM. Journal of Engineering Science and Technology, 16(2), 1416-1425.
37. Altin M, Nalbant M, and Taskesen A 2007The effects of cutting speed on tool wear and tool life when machining Inconel 718 with ceramic tools Materials and Design.28 2517-22.
38. Shrishail Sollapur & Shraddha Gunjawate, “Structural Analysis and Topology Optimization of Leaf Spring Bracket”, *International Journal of Engineering Research & Technology (IJERT) Vol. 9 Issue 07, July-2020. pp. 1448-1494*
39. Shrishail Sollapur, M S Patil, S P Deshmukh, “Advancement and Experimental Investigation of Voice Coil Actuator utilizing Flexural Bearing”, *Journal of Mechatronics and Automation, STM Journals, Vol 5,Issue 2, 2018. pp. 40-45*

40. S B Sollapur, “Evaluation of Stiffness and Parametric Modeling of XY Flexure Mechanism for

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Precision Applications", *Journal of Modeling and Simulation of Materials*, vol. 1, no. 1, pp. 8-15, May 2018. doi: 10.21467/jmsm.1.1.8-15

41. S B Sollapur et. al *"Experimental Investigation of High Precision XY Mechanism", International Journal of Mechanical Engineering and Technology,9(5),2018,pp.43–50.*
42. P M Waghmare, Shrishail Sollapur et al, "A Review Paper On Flexure" *International Journal for Science and Advance Research In Technology,* Vol 3, Issue 10, 2017.
43. Toradmal, Kuldeep P., Pratik M. Waghmare, and Shrishail B. Sollapur. "Three point bending analysis of honeycomb sandwich panels: experimental approach." International Journal of Engineering and Techniques 3.5 (2017).
44. S B Sollapur et. al "Mechanical Properties of Bamboo Fiber Reinforced Plastics", IJSART - Volume 3 Issue 9 –SEPTEMBER 2017 ISSN [ONLINE]: 2395-1052, Page | 365-368
45. Khilare, Umesh A., and S. B. Sollapur. "Investigation of Residual Stresses and Its Effect on Mechanical Behaviour of AISI310." *Journal for Research* | Volume 02 | Issue 05 | July 2016 ISSN: 2395-7549, PP 42-46.
46. Patil, Sandeep, et al. "Thermo-Mechanical Analysis of Crankcase." IOSR. J. of Mechanical and Civil Engineering 12.5 (2015): 13-18.
47. Khilare, Umesh A., and S. B. Sollapur. "Investigation of Residual Stresses and Its Effect on Mechanical Behaviour of AISI310."
48. HallA M, and Beuhring V F 1972Thermal And Mechanical Treatments for nickel and nickel base alloy and effects on Mechanical properties. Report Nasa. SP 5106.
49. Li C, Yuan Z, Fan Y, He S, Xuan W, Li X, Zhong Y, and Ren Z 2017 Microstructure and mechanical properties of a Ni-based super alloy after heat treatment in a steady magnetic field Journal of Materials Processing Technology.246 176-84.
50. Li C, Guo G, Yuan Z, Xuan W, Li X,Zhong Y, and Ren Z 2017 Chemical segregation, and coarsening of g'precipitates in Ni-based super alloy during heat-treat mentinan alternating magnetic field Journal of Alloys and Compounds.720 272-76.
51. Umesh K, "Identifying Design Alternative For Piping System Upon Assessment Of Composite Material For Suitability To The Engineering Application", In International *Journal of Advanced Engineering Research and Studies* EISSN2249– 8974 III/IV/July-Sept.,2014
52. Shrishail, B. Sollapur, and P. Deshmukh Suhas. "XY scanning mechanism: a dynamic approach." International Journal of Mechanical Engineering and Robotics Research 3.4 (2014): 140.
53. Sui S, Tan H, Chen J, Zhong C, Li Z, Fan W, Gasser A, and Huang W 2018 The influence of Laves phases on the room temperature tensile properties of Inconel 718 fabricated by powder feeding laser additive manufacturing *Acta Materialia.*10 032.
54. Ghosh S,Yadav S,and Das G 2008 Study of standard heat treatment on mechanical properties of Inconel 718 using ball indentation technique *Materials Letters.*62 2619-22.
55. Waghmare, Pratik M., Pankaj G. Bedmutha, and Shrishail B. Sollapur. "Investigation of effect of hybridization and layering patterns on mechanical properties of banana and kenaf fibers reinforced epoxy biocomposite." Materials Today: Proceedings 46 (2021): 3220-3224. https://doi.org/10.1016/j.matpr.2020.11.194
56. Mukhtarova KS, Shakhov R V, Smirnov V V, and Mukhtarov S K 2019 Microstructure and microhardness studies of Inconel718, manufactured by selective laser melting and subjected to severe plastic deformation and annealing IOP Conf. Series: Materials Science and Engineering.672012049.
57. Molodov D A, Gunster C,and Gottstein G 2014 Grain boundary motion, and grain growth in zinc in a high magnetic field *J Mater Sci.*49 3875-84.
58. BozorthR M, and Dillinger J F 1935 Heat treatment of magnetic materials in a magnetic field II. experiments with two alloys Journal of Applied Physics.6 285-91.
59. Shinde, Tarang, et al. "Fatigue analysis of alloy wheel using cornering fatigue test and its weight optimization." Materials Today: Proceedings 62 (2022): 1470-1474. https://doi.org/10.1016/j.matpr.2022.02.023
60. Sollapur, Shrishail, M. S. Patil, and S. P. Deshmukh. "Position Estimator Algorithm Implementation on Precision Applications." Materials Today: Proceedings 24 (2020): 333-342.

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https://doi.org/10.1016/j.matpr.2020.04.283
61. Baviskar, D.D., Rao, A.S., Sollapur, S. et al. Development and testing of XY stage compliant mechanism. Int J Interact Des Manuf (2023). https://doi.org/10.1007/s12008-023-01612-1
62. Dong Y, Shuai S, Yu J, Xuan W, Zhang Z, Wang J, and Ren Z 2018 Effect of High StaticMagneticFieldonthe1MicrostructureandMechanicalPropertiesofDirectionalSolidifiedAlloy2024 Journal of Alloys and Compounds.03 259.
63. Sui S, Zhong C, Chen J, Gasser A, Huang W, and Schleifenbaum J H 2017Influence of solution heat treatment on microstructure and tensile properties of Inconel 718 formed by high-deposition-rate laser metal deposition Journal of Alloys and Compounds.11004.
64. Sollapur, S., Patil, M.S., Chaporkar, K., Misal, A., Bhoyar, R., Dhole, K. (2020). Design and Development of Constrain Based XY Flexural Mechanism. In: Pawar, P., Ronge, B., Balasubramaniam, R., Vibhute, A., Apte, S. (eds) Techno-Societal 2018. Springer, Cham. https://doi.org/10.1007/978-3-030-16962-6_27
65. Chikkangoudar, R.N., Patil, C., Panchal, R.N. et al. Investigating Joint-Free Mechanical Systems with PLA and ABS Materials Using the Fuse Deposition Modelling Method. J. Inst. Eng. India Ser. D (2024). https://doi.org/10.1007/s40033-024-00659-y
66. Vinod, M., Kumar, C.A., Sollapur, S.B. et al. Study on Low-Velocity Impact Performance of Chemical Treated Flax Fibre-Reinforced Aluminium 6082 Laminates. J. Inst. Eng. India Ser. D (2024). https://doi.org/10.1007/s40033-024-00657-0
67. Panchal, R.N., Sollapur, S.B., Suryatal, B.K. et al. Investigating the Mechanical Aspects of Natural Fiber-Based Structural Composite for Hybrid Energy Storage Applications. J. Inst. Eng. India Ser. D (2024). https://doi.org/10.1007/s40033-024-00681-0
68. Sollapur, S., Shinde, T., Raut, S., Atpadkar, A., Nimbalkar, P., Rathod, M. (2024). Design and Development of High-Precision Scanning Flexural Mechanism Using PID. In: Sachdeva, A., Goyal, K.K., Garg, R.K., Davim, J.P. (eds) Recent Advances in Operations Management and Optimization. CPIE 2023. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-99-7445-0_4
69. Ramesh, M.R., Medabalimi, S., Kumar, R.S. et al. Cyclic Oxidation and Hot-Corrosion Behavior of HVOF-Sprayed NiCrAl Coating on Industrial Boiler Tube Steels. JOM (2024). https://doi.org/10.1007/s11837-024-06526-1
70. Patwari A U, Mahmood M N,Noor S, Haque Z, and Shovon M D 2013Investigationofmachinabilityresponsesduringthe magnetic field 5th BSME International Conference on Thermal Engineering.56 713-18.
71. Rao, H.J., Sollapur, S.B., Varma, C.D., Gara, D.K., Singh, S., Sharma, S. (2024). An Observer-Based Solution for Structural Health Monitoring of Mechanical Systems Subjected to Unknown Inputs. In: Singh, S., Ramulu, P.J., Gautam, S.S. (eds) Recent Advances in Aerospace Engineering. MRAE 2023. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-97-1306-6_48
72. Maruthi Prashanth B H, Ramesh S, P S Shivakumar Gouda, Gajanan M Naik, Priyaranjan Sharma, C Jagadeesh, Mahantesh M Math and Gajanan Anne.Impact of ply stacking sequence on the mechanical response of hybrid Jute-Banana fiberphenoplast composites Materials Research Express, Volume 11, Number 5.DOI 10.1088/2053-1591/ad425c
73. Jabiulla, S., Kirthan, L.J., Kumaraswamy, G.N. et al. Evaluation of the Reliability of Computational Fracture Mechanics Approaches for Compact Tension Specimen. J. Inst. Eng. India Ser. D (2024). https://doi.org/10.1007/s40033-024-00697-6
74. Jabiulla, S., Kirthan, L.J., Kumar, R.G. et al. Experimental and Numerical Evaluation of In-plane Tensile Mode Stress Intensity Factor for Edge Crack Using Empirical Formulation of Displacement Extrapolation Method. J. Inst. Eng. India Ser. D (2024). https://doi.org/10.1007/s40033-024-006 40-9
75. Dokku, S.R., Shivaraj, B.W., Harshith Raj, A. et al. Hydrothermal Synthesis, Characterization of WO3 Nanoparticles for Ethanol Gas Sensor Application. J. Inst. Eng. India Ser. D (2023).

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https://doi.org/10.1007/s40033-023-00543-1
76. Kattimani, M. A., Venkatesh, P. R., Kirthan, L. J., Math, M. M., Prapul Chandra, A. C., Hegde, R., … Kumar, S. (2023). Design and optimization of fatigue life studies on induction hardened IN718 alloy for gas turbine applications. Advances in Materials and Processing Technologies, 1–13. https://doi.org/10.1080/2374068X.2023.2256121
77. L.J. Kirthan, V.A. Ramakrishna Hegde, R.G. Girisha Kumar, Evaluation of mode 1 stress intensity factor for edge crack using displacement extrapolation method. Int. J. Materials and Structural Integrity 10, 11–22 (2016)

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