THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22-Issue-37-December -2019

Laser assisted machining and benefits: A Review

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Abstract

Laser machining is the technique in which machinability of hard to cut material can be improved. Present Research Work is to revive and collect the use of laser assisted machining for hard to machine material, advantages and problems coming during this hybrid machining A large amount of work has already been done on LAM to increase the tool life, cutting forces, residual stresses, cutting temperature and surface finish. Hard to cut alloys like as Ti and Ni are broadly used in medical, nuclear, shipping and aerospace industries due to its properties. In day today researches, researchers paid a lot of attention on improving the machinability of this material more effectively by using any external energy assisted machining. The current research paper is a review paper on laser assisted machining to find the useful outcomes using different techniques on different material. Results coming out of laser assisted machining are also been compared to conventional machining in this present paper.

Keywords: *Laser assisted machining, turning, hard to machine material*

Introduction

Laser assisted process is broadly observed in different industrial application including aerospace, machine tools, automobile, medical and nuclear plants etc. Materials like Ni and Ti based super alloys chromium alloys are of great strength and applications like heat resistance. The main motivation for this hybrid machining process is to decreases the cutting forces, increases in tool strength, reduce chatters, improve the material removal rate and increases in surface finish. Heating the metal less than the recrystallization temperature will decreases its strength without the changes it its properties. Different heats sources can be used to heat the metal to be machined are like laser, induction coil, gas flame and plasma. Different heat sources to be used for heating the metals are having different advantages and disadvantages. The alloys based on titanium and cobalt are having good STW ratio, excellent resistance to corrosion and also having ability to continue with its properties like great strength even at high temperature. Hard to cut material are growing currently because of its properties and life of the product. Difficult to cut materials are considered as the hard materials due to the several difficulties coming during the machining like as heat production in cutting area and heavy friction b/w tool chip fro BUE formation.

Laser assisted machining:

Laser assisted is one of the most suitable process generally used to machine difficult to cut material in which work material is pre-heated with the help of high intensity laser power source to raise the temperature low than the recrystallization temp before machining with the cutting tool. Temperature raised by the laser power is softens the material to be machined changing the

ISSN:0971-1260
Vol-22-Issue-37-December -2019

behavior of material to ductile. At the raised temperature the yield strength and ductility of the hard material decreases due to which the cutting forces get decreases and tool wear also decreases which tends to improve the surface finish and life of the tool too. Figure 1 shows the geometric view of laser assisted machining.

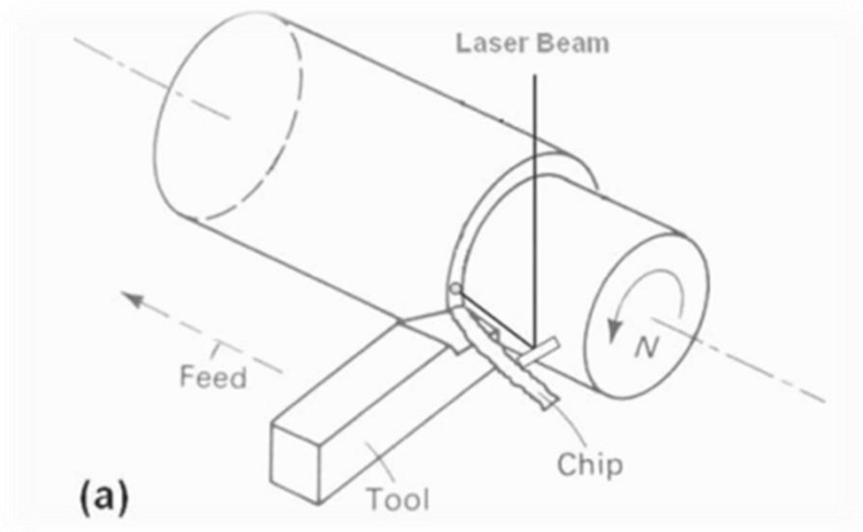

Figure 1. Geometry of LAM

Out of the literature it is observed that number of methods are there to heat the surface of the work material in which laser is most prominent and it is also observed that CO_2 and Nd:YAG laser are two widely used laser for this purpose. Nd:YAG laser is more beneficial as compared to that of CO_2 due to its less absorptivity of laser. Most of the research work has been focused on the advantages laser assisted machining. The most effective parameters associated with LAM are cutting velocity, feed, laser Watt and spot diameter of the beam. A study based on DOE is required to be find the influence of LAM parameter.

Literature

Wang *et al.* (2003) investigated the improvement in surface roughness by 250% while using plasma as a preheating equipment on turning of Inconel 718 material by carbide tool, also decreased cutting force of around 29.9%–49.9% and increased tool life of up to 169% was found over old machining. **Anderson *et al.* (2006**) analyzed that with increase in preheating temperatures (by using laser) to 620°C while turning on Inconel 718 material by carbide tool results shows a 24.9% decrease in cutting energy, an increase of two hundred to three hundred percent tool life and improves surface finish. Shi et al. (2008) analyzed numerically and experimentally that in comparison with conventional cutting of Inconel 718 by carbide tool, the force in Laser assisted machining decreased by 23%–45%. However, the chip formation increased by 41% by using pre temperatures of 799°C. Amin et al. (2008) investigated that by applying heating temperatures of approximately 49°C-149°C (by using induction coil) on milling of D2 using cubic boron nitrate PCBN tool, the surface finish and charter result decreased. Germain *et al.* (2011) explored that the material (in chip formation)

ISSN:0971-1260
Vol-22-Issue-37-December -2019

was reduced when the preheating temperature was increased to 700°C while turning of 42CrMo4 steel by carbide tool in heat assisted machining. It was proved that the cutting forces could decreases by as much as 40%. Muhammad *et al.* (2014) found that there was reduction of cutting force in the range of 79%–84% when the preheating temperature applied approximately 299°C by using electricity resistance on thermally enhanced ultrasonically assisted machining of Ti-15333 alloy using carbide tool. Na-Hyean *et al*. (2015) found the laser assisted turn-mill process was productive as compared to the laser assisted turning. AISI 1045 steel was used to study the influence of the laser power, cutting speed rate and the depth of cut on the cut forces and surface finish machining process were performed to machine from round shaped material to square shaped product. Cutting force and surface roughness was found decreased with the increases in the depth of cut. Seong-Ju Hwaye *et al.* (2016) performed the analyses and experiment on Silicon nitride machining by using three heating methods, one way, zig-zag and back and forth motion of laser on work piece. Thermal analysis was done by absorption 0.7, convection heat 5, laser power 150W, laser beam size 3mm and feed rate of 100mm/min, machining at 40 mm/min, rotational speed 4000 rpm, depth of cut 0.15mm. Best results were found at laser power of 220W. Surface roughness was found best at 210 W. Back and forth motion method was verified to be the most effective method. Sim Seop and Lee Man (2016) investigated the power if a laser used for preheating of work piece on titanium alloy at different tool path inclination angle and rotated angle with to axis. Analytical as well as experimental work was done through which it is observed that 80W laser power is optimal fitted preheating temperature of 450-600°C. Heating temperature start increasing at 75° tool path inclination angle.

Venkatesh and Chakradhar (2017) studied the effect of heated machining parameters on the machining of super alloy. Oxyacetylene flame was used to give heat to the work piece. It was found that cutting forces and surface finish decreases with increase in cutting speed and work piece temperature while the work piece degrees increases as tool wear decreases. XRD results of the specimen were done which shows there was no effect of heat on phase change and broadening of the peaks were observed same at different machining conditions. Riaz. Woo and Lee (2019) investigated the improvement of tool life by using combin of induction heating and laser heat sources as high strength material Inconel718. Tool life was found to be improved about 70.2% in laser induction assisted machining as compared to single heat assisted machining. Tool life was found to be improves when distance between tool and material was increased to 7 mm. Surface roughness was also found to be enhanced when TAM with multi heat sources were used.

In any machining operation measurement of forces during cutting of material are of great importance in order to estimate the power consumption and process efficiency. Identically it is also important to look on the cutting temp. which is a important factor for tool wear and tool life. The usage of more than one cutting tool leads to improved surface finish of the machined component. The cutting tool apart from removing the work material also provide support to the work piece in multi-tool turning. An alternate method of increasing the productivity is by engaging more tools at the same time to machine a component. It gives rise to multi-tool machining. Review of literature on duplex tool machining is very limited. Researchers have found good results on conventional machining but area of research remains unexplored in the

ISSN:0971-1260
Vol-22-Issue-37-December -2019

multi tool turning process. Few of the papers are discussed on the multi tool machining as follows:

Conclusion:

The review results of heat assisted machining of hard to cut material are summarized as follows:

1. It was found from the literature that the LAM process can be utilized to enhance the effectiveness of metals with hard- to- cut when compared to common methods.

2. From the review it is concluded that the efficiency of LAM can be increased by selecting the optimum values of process parameters.

3. Numerical analysis can be developed to validate the results in proper way in lesser time which surly decreases the cost of the products.

4. In most of the researches researchers are using the Laser assisted machining for the turning only but this hybrid process can be used for other materials removal processes like drilling, milling and grinding in production departments.

5. By literature it is also seen that cutting forces on tool are decreasing as well as surface finish is also improving.

References:

G. Germain, P. D. Santo and J. L. Lebrun. Comprehension of chip formation in laser assisted machining. *International Journal of Machine Tools & Manufacture,* vol. 51, pp. 230–238,2011.

H. Attia, S. Tavakoli, R. Vargas and V. Thomson. Laser-assisted high-speed finish turning of superalloy Inconel 718 under dry condition. *CIRP-Annal-Manufacturing Technology*, vol. 59, pp. 83–88,2010.

Venkatesh, G. and Chakradhar, D. (2017). Influence of Thermally Assisted Machining Parameters on the Machinability of Inconel 718 Superalloy. *Silicon*, 9(6), pp.867-877.

ISSN:0971-1260
Vol-22-Issue-37-December -2019

Shi,H.Attia,R.VargasandS.Tavakoli.Numericalandexperimentalinvestigation of laserassisted machining of Inconel 718. *Machining Science and Technology*, vol. 12, pp. 498–513,2008.

Sim, M. and Lee, C. (2015). Determination of optimal laser power according to the tool path inclination angle of a titanium alloy workpiece in laser-assisted machining. *The International Journal of Advanced Manufacturing Technology*, 83(9-12), pp.1717-1724.

Woo, W. and Lee, C. (2019). Innovative use of multi-heat sources for improvement of tool life in thermally assisted machining of high-strength material. *Journal of Manufacturing Processes*, 38, pp.30-37.

Z. Y. Wang, K. P. Rajurkar, J. Fan, S. Lei, Y. C. Shin and G. Petrescu. Hybrid machin-ing of Inconel 718. *International Journal of Machine Tools & Manufacture*, vol. 43, pp. 1391–1396,2003

