Available online at www.sciencedirect.com

ScienceDirect

Materials Today: Proceedings 4 (2017) 1230–1235

materialstoday: PROCEEDINGS

www.materialstoday.com/proceedings

5th International Conference of Materials Processing and Characterization (ICMPC 2016)

Applications of LASER Inspection for Precision Components

Satyanarayana A.*, Alok Singh Chauhan, Pradyumna R., Baig MAH

Defence Metallurgical Research Laboratory, Kanchanbagh P.O., Hyderabad – 500 058, India.

Abstract

LASER based inspection systems are widely used in precision manufacturing system in the recent years. LASER CMM in which a LASER probe attached to Co-ordinate measuring machine is capable rapid measurement of complex 3D sculptured geometry. These machines are capable of capturing large number of data points in the order of thousand of points per second with good accuracy. This inspection is non contact, suitable for fragile and soft components and it is faster and complete surface profile data available in least time. This paper describe various applications of LASER inspection for precision component like turbine blade wax pattern and ceramic core and also describes the development of land based power generation turbine blade through reverse engineering methodology.

Keywords: LASER CMM, Inspection, Ceramic cores, Wax patterns, Reverse Engineering

1. Introduction

Aerospace components require high precision and close dimensional tolerances. Inspection play key role in development of these components with desired accuracies and dimensional tolerance. Various inspection systems like 3D CMM are generally used for dimensional conformity of these components. In this inspection system, a stylus touches the surface of the component, thereby recording the co-ordinates of the component. But these inspection systems required lot of time in alignment of component and special skills are required in programming the inspection procedures. More over, the inspection process touch the component, so it cannot be used for fragile components and it is very slow and gives information about the limited number of features. With advances in LASER inspection systems, non contact inspection is possible, which is very useful for inspection of fragile and

* Corresponding author. Tel.: +91-40-24586818; fax: +91-40-24340683.
*E-mail address:*satyanarayana.a@gmail.com

flexible surfaces. LASER CMM is an important system for rapid inspection of components [1]. Fig. 1. Show a typical turbine blade, in which geometry specified in number aerofoil cross sections, which are stacked through a stacking axis. These profiles have stringent dimensional tolerances to meet the aerospace quality requirements. Table 1. shows typical dimensional tolerance of aero engine turbine blade.

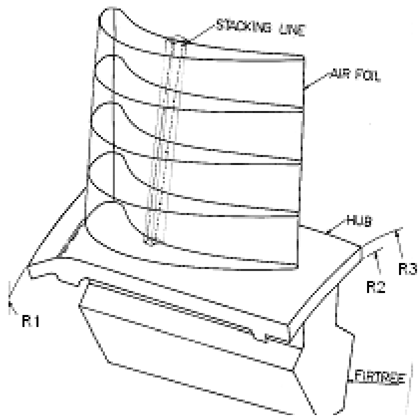

Fig. 1. Definition of Aerofoil Geometry

Table1. Dimensional Requirements of turbine blades & vanes

No	Property	Tolerance Specified on Casting
1	Form	± 0.13 mm
2	Stacking Axis	
	X-Axis	± 0.15 mm
	Y- Axis	± 0.15 mm
3	Rotation	± 0.50 Deg

2. Non-Contact CMM Laser Inspection

Non-contact LASER CMM was procured from M/s. Laser Design Inc. USA, which consists of high precision roller bearings in X, Y and Z axis and a precision artificial granite table. LASER probe is mounted in Z axis ram of CMM. The LDI Laser CMM system procured and installed in DMRL consists of a 3D laser scanner, a PC, and software that extracts, displays, and manipulates the data (Fig. 2). The LASER probe consists of a laser diode, whose output is passively spread into a line, and two CCD arrays. The CCD arrays are positioned on opposite sides of the laser beam in a fixed orientation, so that each CCD's position relative to the laser is known. The LASER sensor is a single viewpoint laser stripe. Laser stripe sensors, which are significantly faster than simple laser point sensors, work by projecting a line of laser light onto the object while a small CCD camera views the line as it appears on the surface. Apart from this, the system consists of rotary table -and a flip plate through which we can capture both top and bottom surfaces in all directions of the components with a high degree of resolution. The advantage of the laser scanner is that it gives a greater density of data, rather than cross sections of an object, thus gives complete surface data of components.

3. LASER CMM Inspection Procedure

The procedure for measurement and analysis of ceramic cores is as given below:

- The components are positioned in desired location and orientation on the rotary table.
- Reference spheres are initially scanned for accurate merging of different scanned data.
- Limits of scanning are defined based on the component geometry and the complete surface of the component is scanned.
- Component surface is scanned, generating cloud point data in the Surveyor Scan Control software.
- The fixture is flipped and the component is scanned for generating cloud point data on the opposite side.
- Cloud point data is exported to Geomagic Software, where the density of the data is reduced and optimized.
- Nominal CAD model is imported and best-fit against measured surface data carried out using Geomagic Qualify software.
- Deviation profile in terms of colour mapping and sectional data (Ref. Fig 4) are generated to assess dimensional acceptability of the component.