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## Appendix A1: Microstructure and mechanical testing methods

### X-ray diffraction (XRD) test

Residual stress has been measured using an XRD system (Model: Empyrean material research diffractometer (MRD), Make: Panalytical) with Co-K $\alpha$  radiation at  $2\theta$  of  $71.225^\circ$  with a step size of  $0.07^\circ$  and time per step of 3.5 s. For this measurement, the range of angle was taken as 0 to  $40^\circ$  at a step of  $8^\circ$ . To calculate the residual stress, the software “Stress Plus” provided by the Malvern Panalytical was used. A Rigaku Miniflex 600 X-ray diffraction (XRD) system with Cu (K $\alpha$ ) radiation within the angular range ( $2\theta$ ) of  $30^\circ - 90^\circ$  at the scan rate of  $5^\circ/\text{min}$  was used to check the peaks and characterize the phases of the different components.

### Archimedes’ principle

To measure the density of solid components, Archimedes’ principle was used which states that when a solid body is immersed in liquid, it experiences a buoyant force acting upward and the magnitude of this force is equal to the weight of the liquid displaced by the solid part. The density of a solid part depends on the weight of the solid part in air, weight of the solid part in liquid, density of a liquid, and density of air. It can be estimated from the following formula:

$$\rho_{solid} = \frac{w_{air}}{w_{air} - w_{liquid}} (\rho_{liquid} - \rho_{air}) + \rho_{air} \dots\dots\dots(A1)$$

where  $\rho_{solid}$  is density of the solid body,  $\rho_{air}$  is the density of air,  $\rho_{liquid}$  is the density of the liquid,  $w_{air}$  is weight of the solid part in air and  $w_{liquid}$  is weight of the solid part in the liquid.

### **Scanning electron microscopy (SEM)**

High-resolution scanning electron microscope (SEM) (Nova Nano SEM 450) equipped with energy dispersive spectrometer (EDS) (Team Pegasus Integrated EDS-EBSD with Octane Plus and Hikari Pro) for finding out the elemental distribution in the relevant phases.

### **Electron backscattered diffraction (EBSD)**

Electron backscatter diffraction (EBSD) analysis was done on different samples. After polishing, the samples were electropolished in 80% methanol and 20% perchloric acid at  $-20^{\circ}$  C at 12V for 15s, and then EBSD was carried out on the EFI Quanta 3D field emission gun (FEG) system for the micro-texture characterization.

### **Tensile test**

Testing of all the tensile specimens was carried out on an INSTRON 8801 universal testing machine (100 kN load cell) at room temperature and a uniform rate of displacement of 1 mm/min and as per the ASTM E8 standard.

### **FLIR thermal camera**

The FLIR E75 thermal camera was employed to detect the grinding temperature during the process under different grinding environments. The emissivity of the thermal camera has been taken as 0.34 for additively manufactured Ti-6Al-4V workpiece material. The thermal camera was fixed at a distance of 600 mm from the grinding zone using a tripod after performing number of experiments to optimize the distance between the workpiece and the camera for proper focus on the grinding zone.

### **Atomic force microscopy (AFM)**

3D surface morphological characteristics of the grinding surface were evaluated by AFM (NTEGRA Prima, NT-MDT Service & Logistics Ltd.)

### **X-ray photon spectroscopy (XPS)**

X-ray photon spectroscopy (XPS) (Model:  $K_{\alpha}$  XPS, Make: Thermo Fisher Scientific) fitted with a monochromatic (1486.6 eV) radiation source established at 150 W was employed to analyse the chemical composition and observe the evolution of oxide layers on sample surfaces, as well as to identify the prominent peaks on the surface of the samples. The detection region selected for XPS analysis was  $4 \times 4 \mu\text{m}$ . The elements present on the surface of the oxide films were analysed by XPS Advantage software. The XPS spectrums of the surface layer of corrosion samples were obtained.

### **Raman spectroscopy**

The presence of  $\text{TiO}_2$  formed on the surfaces was analyzed by high resolution Raman spectroscopy (Model: Alpha 300, Make: WiTech Germany) with an excitation wavelength of 532 nm.



## **LIST OF PUBLICATIONS**

1. **Singh, P.K.**, Kumar, S., Jain, P.K. *et al.* Effect of Build Orientation on Metallurgical and Mechanical Properties of Additively Manufactured Ti-6Al-4V Alloy. *Journal of Material Engineering and Performance* (2023). <https://doi.org/10.1007/s11665-023-08218-4>
2. **Singh, P.K.**, S. Kumar, and P.K. Jain, Effect of cryogenic grinding on surface characteristics of additively manufactured Ti-6Al-4V alloy. *Surface Topography: Metrology and Properties*, 2023. 11(1): p. 015014. <http://doi.org/10.1088/2051-672X/acad16>
3. **Singh P.K.**, Kumar S., Jain P.K., Surface Integrity of Cryogenically Finished Additively Manufactured and Conventional Ti-6Al-4V Alloy. *Metals*. 2023; 13(4):693. <https://doi.org/10.3390/met13040693>
4. **Singh, P.K.**, Kumar, S., Jain, P.K. *et al.* Effect of Heat Treatment on Electrochemical Behavior of Additively Manufactured Ti-6Al-4 V Alloy in Ringer's Solution. *Journal of Material Engineering and Performance* (2023). <https://doi.org/10.1007/s11665-023-08636-4>
5. **Singh P.K.**, Kumar S., Jain P.K., Effect of Build Orientation and Heat Treatment on Electrochemical Behavior of Laser-Powder Bed Fusion Fabricated Ti-6Al-4 V Alloy (**to be communicated**)
6. **Singh P.K.**, Kumar S., Jain P.K., Effect of Build Orientation and Heat Treatment on Wear and Biological Behavior of Laser-Powder Bed Fusion Fabricated Ti-6Al-4 V Alloy (**to be communicated**)

## **CONFERENCES**

1. **Singh, P.K.**, Kumar, S. and Jain, P.K. (2023). Effect of heat treatment on wear behaviour of laser-powder bed fusion processed Ti-6Al-4V Alloy (Oral presentation, *Triboindia 2023* held at NIT Srinagar). International Conference on Tribology with Theme: sustainable development through tribology. 5-7 October 2023

## **BOOK CHAPTERS**

1. **Singh, P.K.**, Kumar, S. and Jain, P.K. (2023). Additive Manufacturing Technologies and Post-processing, Design Optimization, and Material Considerations for Reliable Printing. In Nanotechnology-Based Additive Manufacturing (eds K. Deshmukh, S.K.K. Pasha and K.K. Sadasivuni). *Wiley*. <https://doi.org/10.1002/9783527835478.ch2>
2. **Singh, P.K.**, Kumar, S., Verma, G.K., Jain, P.K. (2023) Post-processing techniques of additively manufactured Ti-6Al-4V alloy: A complete review on property enhancement. In Post-processing Techniques for Additive Manufacturing (eds Zafar Alam, Faiz Iqbal, Dilshad Ahmad Khan). *CRC Press*, p 245-273. <https://doi.org/10.1201/9781003288619>