UNIT-4- POWDER BASED ADDITIVE MANUFACTURING SYSTEMS

Case Studies on SLS

In the present study, tungsten carbide (WC) and cobalt (Co) powder mixture was sintered through selective laser sintering process using a pulsed Nd:YAG laser. Two different compositions of the powder mixture having 85 wt% WC + 15 wt%Co and 80 wt% WC + 20 wt% Co were used in the experiments. The optimum level of parameters, such as, composition of powder, layer thickness, hatching distance, pulse energy, pulse width and distance from focal plane were obtained by using the Taguchi method for achieving higher density, higher micro-hardness and minimum porosity. The Taguchi design of experiments involving an L-18 orthogonal array was followed. The effects of various sintering parameters were investigated on various responses like density, micro hardness and porosity. The composition of the powder mixture and the pulse energy were found to have significant role on the micro hardness. Hatching distance and cobalt percentage were the main influencing parameters on density and porosity. Surface morphology and formation of inter metallic compounds were analyzed through scanning electron microscopy (SEM) and X-ray diffraction (XRD) techniques. In the present study, tungsten carbide (WC) and cobalt (Co) powder mixture was sintered through selective laser sintering process using a pulsed Nd:YAG laser. Two different compositions of the powder mixture having 85 wt% WC + 15 wt%Co and 80 wt% WC + 20 wt% Co were used in the experiments.

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Laser	Power range (W)	Wavelength (μm)	Typical industrial applications
CO_2-flowing gas (continuous wave and pulsed)	500–45,000	10.6	Cutting, welding, cladding, free forming, and hardening
CO_2-sealed (pulsed)	10–1,000	10.6	Micro-welding, cutting, scribing and drilling
Nd:YAG (continuous wave)	1000–5000	1.06	Welding, cutting, cladding and hardening
Nd:YAG (pulsed)	10–2000	1.06	Micro-welding, cutting, drilling, scribing and marking
Nd:YAG diode pumped (pulsed)	10–500	1.06	Cutting, drilling, scribing, marking and micro-machining
Excimer (pulsed)	0.001–400	0.157–351	Micro-machining, marking and photolithography

Sintering Mechanism of WC–Co Powder

The SLS process is more effective with the mixture of two metal powders comprising high and low melting points. The low melting point powder acts as a binder. The laser energy is adjusted in such a way that the temperature at the laser and metal powder mixture interaction zone crosses the melting point of one powder but does not reach the melting temperature of the other powder. The melted material flows through the void in between the powder particles, consolidating powder particles in the process. In this way, the laser scans over the powder layer, converting it to a solid layer. The density of the sintered part can be increased by reducing the porosity which can be accomplished by selecting the binding material with smaller particle size than that of the structural material. The bigger particle size of binder material has higher melting enthalpy because of its large mass which leads to partial melting. Therefore, the void is not filled up. As a result, the density of the component reduces. On the other hand, smaller particle size leads to complete melting and the melt flows through the void and forms cluster structures. In this way, the density of the sintered object can be increased in the SLS process.