Selective laser melting of iron

Engineering

Paraphrased Final al Affiliation: It was deduced, from various research literature, that there was impossibility of steel samples assembled by SLM, with full density. The difficulty is as a result of special chemical properties of crucial elements within the steel composition. Fe, which serves as a matrix element of steel, is very reactive to oxygen. Therefore, a certain degree oxidation is unavoidable under normal SLM conditions and powder handling [1]. More so, during laser processing, there is a likelihood of occurrence of the balling phenomena. This is as a result of the presence of a contamination layer of oxide on the surfaces of steel melt. It is imperative to note that the carbon content of steel plays a critical role in determining processability of SLM. High carbon content also has adverse effect on high speed steel and SLM produced steel, since they portray a limited densification response. Wright et al. [2], in his research, found out that with increase in carbon contents, there is increase in the thickness of the carbon layer sifted on the melt surface. Just like the oxide layer, the carbon layer has a critical influence mostly on diminishing wettability and causing the melt to spheroidise rather than flow across the underlying surface. In addition to this, the brittleness of SLM manufactured high carbon content steel is increased by the formation of complex interfacial carbides at grain boundaries. Childs et al. [4], through his research, concluded that the dissolution of carbides is favored by increasing the heat flow in the treated powder. On the same breath, increasing heat flow homogenizes distribution of alloying elements. Thus, a thin powder layer thickness, which is less than 100mm, is more recommendable for laser melting. This is besides the optimization of laser types and parameters. Due to this reason, high volumetric energy density for both elemental homogeneity and powder

consolidation is achieved [5-7].

In this process, heat generated from a CO2 laser is used to sinter systematic powder layers from 3D objects arranged layer by layer [8]. Due to this, the time required for tool making is considerably reduced. The basis of the sintering is the “ liquid phase sintering mechanism.” The technique involves melting the powder partially. This is also termed as semisolid consolidation mechanism [9-10]. In this form of sintering, a minute amount of liquid phase (comprising between 1 - 10% by volume), with solubility for the solid considered to be at sintering temperature, is employed. When cooled, the liquid crystallize at grain boundaries. Due to manipulation of solid components, as a result of capillary forces exerted on them by the wetting liquid, densification of the solid/liquid system occurs. The resultant success of DMLS and the rate of particle rearrangement are determined by the same capillary forces exerted on the particles themselves. Also, the liquid/solid wetting characteristics play a major role in this [11]. In tandem to this, DMLS, due to its capability of processing pre-alloyed powder and multicomponent metal powder, has demonstrated highly its feasibility.

XRD spectra can be used to reveal any factor that modifies the lattice composition of crystalline samples. For instance, a solid sample with residual stress introduced in it as a result of non-uniform strain, may transpose the diffraction peak orientation in a spectrum. Strain in crystalline substances is brought about by residual stresses. The process involves stretching or compressing bonds between atoms. As a result, the crystallographic layout’s array is manipulated, as well as the Bragg angles. It is imperative to note that, owing to the compressive residual stress produced in the short-peening sample, diminishing the spacing transposes the peaks to a higher 2θ in the

spectrum. Nevertheless, it was concluded by other learned researchers that the principal effect of cold work was to shatter the grains such that there minute size was capable of portraying the observed expansion.