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Material optimization and post-processing of sand moulds manufactured by the selective laser sintering of binder-coated Al_2O_3 sands

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Abstract

Novel binder-coated Al_2O_3 sands were prepared for selective laser sintering (SLS) to manufacture complex sand moulds for metal casting. The solidification mechanisms of the coated sands during the SLS and post-curing processes were provided, and effects of binder content, raw sand type and post-curing parameters on the strength and gas evolution were investigated. At the same binder content, the strength of the Al_2O_3 sand SLS specimen is much higher than that of commonly used quartz sand. Therefore, the binder-coated Al_2O_3 sands are very suitable for building large sand moulds with thin walls and delicate structures. On the other hand, to meet the same strength requirement for metal casting process, the Al_2O_3 sands need less binder content, consequently reducing gas evolution and thus improving the quality of final castings. Finally, a large sand mould for casting a complex six-cylinder diesel engine cylinder head was successfully manufactured by the SLS of the binder-coated Al_2O_3 sands, and the final casting with the surface quality and dimensional accuracy meeting the specific design requirements was obtained. The materials and method proposed in this paper not only shortened the trial production cycle of the six-cylinder engine from five months of the traditional casting method to 10 days, but also reduced the cost and improved the casting quality.