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Studies of Rapid Tooling Spraying Technology Using Low Melting Metal Alloy

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Abstract. To manufacture rapid metal tools, an innovative method based on rapid prototyping and high pressure spraying technologies is proposed in this study. The Sn-Bi metal alloy with low melting point and small thermal shrink was used as the spraying materials. Applying an electric heated device and high pressure boost pump, the melting Sn-Bi Alloy went through a small spray nozzle and atomized into semi-melting minute particles. The atomized particles are then deposited and integrated on the surface of intermediate silicone rubber mold, which is made from the rapid prototyping (RP) system and are successfully used to manufacture rapid wax injection mould. Using the thermal spraying system to manufacture rapid metal mold, the surface quality and the dimensional accuracy of the spray mold is excellent and the fabricated cycle time is short.

Introduction

Rapid Prototyping (RP) has received much attention because of die and mold-making of rapid molds in recent years. Rapid Tooling (RT) is a process of directly or indirectly employing rapid prototyping technology to fabricate temporary molds as well as permanent molds [1]. According to the rapid tooling materials, RT technology is classified as soft tooling and hard tooling. The soft material such as silicone rubber is used for the soft tooling. On the contrast, metal, epoxy, low-melting alloy and polyurethane are used for rapid hard tooling material. The soft tooling process is usually applied to the prototype sample and the hard tooling is adopted for the metal mold manufacturing. There were several methods for rapid metal tooling technologies such as casting tooling, sintering tooling, electroplating and spraying metal tooling [2]. Metal spraying is a process that atomizing droplets of metal alloy and spraying upon a substrate to form a thin metal shell [3]. The metal spray techniques have been widely used in related industries over the past few decades, however, due to the high melting point of spray materials of metallic or ceramic powders, metal spraying tooling produced heat resistance of the pattern materials and was not able to form a thick-sprayed coating layer on the substrate. The aim of this research was to develop a high pressure spray technology for different RT applications such as rapid metal mold and wax injection mold. The spray deposition processes of the molten metal powders impacting on the spray molds, splashing and flattening and solidifying have been investigated in this study. The microstructure of spray-formed parts and the factors influencing the coating structure and working surface roughness have also been analyzed carefully.

Experiment Method

A new high pressure spray technology for the application of rapid metal tooling is developed in this study. The fundamental process includes fusing low-melting point alloy powder, atomizing it and depositing it onto the surface of substrate, and the atomized metal droplets adhere and solidify to form a metallic shell. The experimental setup consists of worktable, pressurized pump device, filter system, spray gun and control system as shown in Fig. 1. The Sn-Bi metal alloy (56%Sn and 44%Bi) with low melting point and small expansion ratio can produce high precision coating surface and small thermal

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