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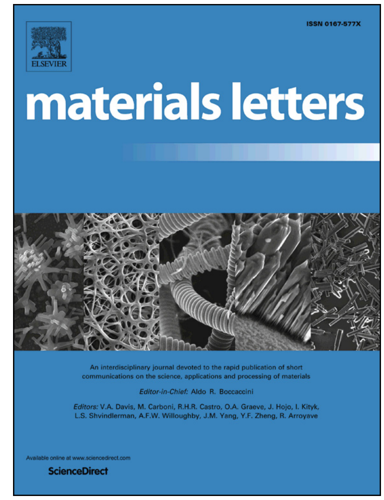

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Abstract

Additive manufacturing by selective electron beam melting (SEBM) was used to process a powder mixture consisting of elemental copper and chromium powders (nominal composition: Cu-25Cr). The melting temperatures of copper and chromium are extremely different. As a result, the copper particles start melting while the chromium ones are still solid. Eventually, also the chromium particles get molten since the local temperatures during SEBM are rather high. The microstructure was analyzed by scanning electron microscopy (SEM) and focused ion beam (FIB)-SEM. It was observed that ultra-fine Cr particles are formed and distributed in the Cu matrix due to the fast cooling rate and subsequent spinodal decomposition.

Key words: Additive manufacturing; Electron beam melting; Microstructure; Solidification; Spinodal decomposition; CuCr alloy

1. Introduction

Since there is an extremely limited mutual solubility between Cu and Cr at room temperature, CuCr alloys exhibit an outstanding mechanical strength and electrical conductivity. Such combination of properties makes CuCr an excellent contact material for medium-voltage and high-power vacuum interrupters. Cu ensures electrical and thermal conductivity of the contact materials while Cr enhances their arc erosion resistance during current breaking operation. Earlier investigations revealed that the microstructure of CuCr contact materials has a significant influence on their actual performance (i.e., switching). As contact materials, CuCr alloys with fine and uniformly distributed Cr particles have superior performance when compared to those with large and segregated Cr phases [1]. These alloys are conventionally manufactured by powder metallurgy, vacuum casting, arc melting, vacuum induction melting, and melt spinning. The main technological drawbacks of these techniques include their poor capability to control the size of Cr phases, inability to avoid formation of Cr dendrite phases along with high complexity and cost. These limitations have motivated researchers to explore new manufacturing techniques with reliable capability in optimizing microstructure of CuCr alloys [2-3].

Aim of this paper is to show that selective electron beam melting characterized by rapid cooling [4] is able to generate materials with microstructures that can hardly be realized by classical