MoCu Composite Manufacturing Technologies

Introduction

Molybdenum (Mo) has a melting point of 2610°C which is higher than copper (Cu)'s boiling point 2595°C. And Cu is insoluble in Mo. Powder metallurgy (PM) is the main method used in MoCu fabrication. This note discusses briefly the three more specific methods used: high-temperature liquid-phase sintering, infiltration and mechanical alloying.

High-temperature liquid-phase sintering

The precursor materials can be pure copper powders, pure molybdenum powders, or a mixture of pure and oxide copper and molybdenum powders. The basic process steps are shown in Fig 1. This method suits high-molybdenum-content composites manufacturing best. In making high-molybdenum-content composites, we often use ultrafine Mo and Cu powders as precursor materials and mechanical surface activation to improve sintering densification. The disadvantage is that molybdenum grains tend to grow excessively. The structure of the MoCu composite obtained by high-temperature liquid-phase sintering is not as homogeneous as that obtained by infiltration which is introduced below.

Fig 1. Basic steps of high-temperature liquid-phase sintering

Infiltration

The infiltration method is now the most common way to manufacture MoCu heat sinks. Fig 2 shows some products of MoCu heat sinks.

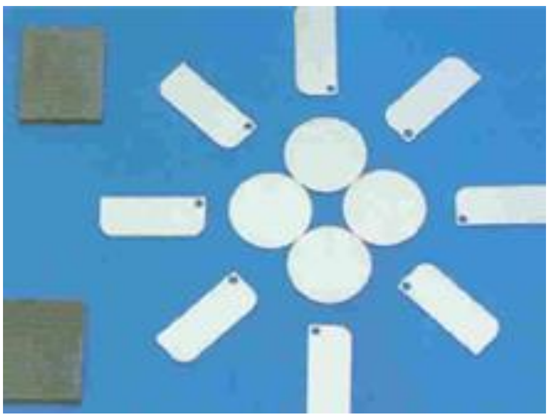

Fig 2. A picture of MoCu heat sinks

Infiltration begins with obtaining a porous Mo body by dry pressing Mo powders to a green body and presintering them in a reducing atmosphere. Then micropores of the Mo skeleton are infiltrated by molten Cu to form a MoCu composite. A typical process is shown in Fig 3. The volume of interstices within the molybdenum skeleton determines the Cu content. As Cu has a close density to that of Mo and the volume of interstice is limited, Cu content is limited to about 30% or less by weight. High-temperature liquid-phase sintering is still the best method to fabricate lower-Cu-content composites (like 85% Mo-15% Cu).

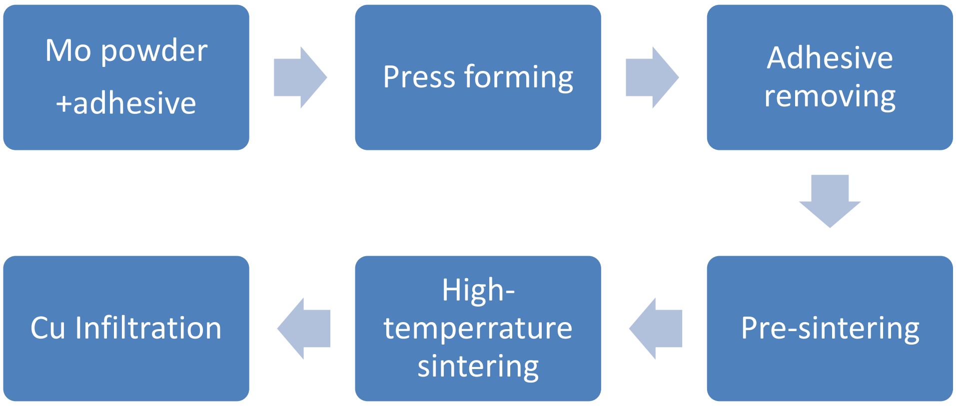

Fig 3. A typical infiltration process of preparing MoCu

Mechanical alloying

MoCu composites produced by Mechanical alloying (MA) tend to have higher electrical conductivity, higher thermal conductivity, and higher hardness. Some nano-scale grain boundaries are formed due to the extensive stress, strain, and dislocation that metal particles undergo during the MA process. Metal particles will be smaller and have larger specific surface area if the ball milling time is longer. Crystal surface and grain boundary defects will increase, too. The powders in a mesostate are easily densified during sintering. Fig 4 shows a typical process of MA.

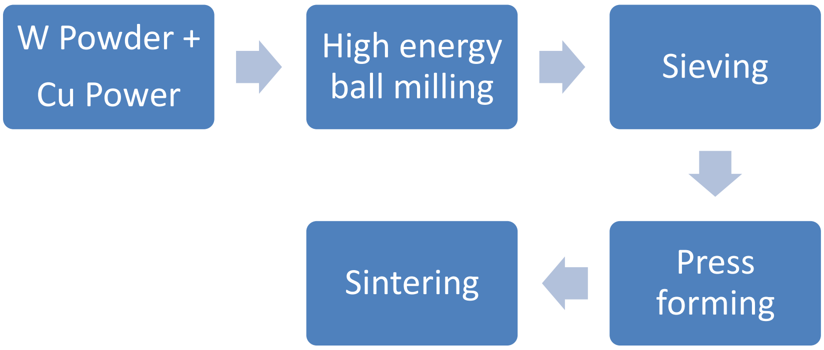

Fig 4. A typical process of MA