A NEW APPROACH FOR RECYCLING OF SCRAP IRON WITH COPPER BY POWDER METALLURGICAL TECHNIQUE

Hideki Kakisawa, Kazumi Minagawa, and Kohmei Halada

National Institute for Materials Science,
1-2-1 Sengen, Tsukuba, Ibaraki, 305-0047 Japan

ABSTRACT

Utilization of copper impurity in iron as reinforcement with the technique of powder metallurgy is carried out. Rapid solidified Fe-Cu powder where copper is supersaturated is prepared and consolidated with heavy rolling at temperatures where no copper liquid phase appears. Copper content, rolling temperature, and heat exposure condition are varied to obtain samples with various microstructures. The samples are subjected to tensile testing and the effect of microstructure on tensile behavior is investigated. The tensile behavior was quite different with the rolling temperature and heat exposure condition. The essential tensile behavior is dominated by the microstructure of the samples.

1. INTRODUCTION

Copper, which is widely used as a conductor, is a major impurity in iron scraps. It has been known that the liquid copper phase in iron causes cracking during hot rolling. Embrittlement due to coarse copper precipitations is a problem, too. However, it is difficult to remove copper from iron. It is necessary to develop a new processing that can make good use of the copper rich iron scrap without removing copper.

Recently, the concept of shutting copper in iron powder and consolidating it has been proposed [1, 2]. In this processing copper is supersaturated by rapid cooling in the iron powder and the powder is consolidated at a temperature where the melted copper phase does not appear. Copper impurity is dispersed in the iron matrix through the process, without either liquid phase or coarse precipitation. Furthermore copper precipitation during cooling in nano- order scale enhances the strength of ferritic iron [3-7]. It was reported that water atomized iron powders with 0.5-15mass% coppers were successfully consolidated with groove rolling [8] at 873-1273K [1, 2].

Understanding of relation between microstructure of the consolidated materials and mechanical properties of them is important to bring out the best performance of the materials. In this study the effect of microstructure on tensile behavior is investigated by tensile testing of the samples with the microstructures changed.

2. EXPERIMENTAL PROCEDURE

Fe-Cu alloy powders (Nippon Atomized Metal Powders Corporation, Tokyo, Japan) were prepared with high-pressure water atomizing method. The mean grain size of the powder was 5μm and copper content was varied from 0.5 to 5mass%. The powder was put in S45C sheaths. They were evacuated at 753K for 54ks in order to remove surface impurities of the powder and then sealed. The sheaths were heavily deformed and consolidated with groove rolling at 873K or 973K. The rolling was done with 11steps; the 40mm diameter sheaths were formed into bars of final diameter 14.3mm. After rolling the consolidated samples were cooled in air. The samples consolidated at 873K were heat-exposed at 1073K in a flowing Ar atmosphere for 3.6-32.4ks. Transverse section of the sample was