Microstructure evolution and formation of needle-like WO3 nanowire during sintering of submicron tungsten particles

M. Ahangarkani, K. Zangeneh-madar, S. Borji

PII: S0263-4368(17)30607-8
DOI: doi:10.1016/j.ijrmhm.2017.09.010
Reference: RMHM 4519

To appear in: *International Journal of Refractory Metals and Hard Materials*

Received date: 1 September 2017
Revised date: 15 September 2017
Accepted date: 21 September 2017

Please cite this article as: M. Ahangarkani, K. Zangeneh-madar, S. Borji , Microstructure evolution and formation of needle-like WO3 nanowire during sintering of submicron tungsten particles. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Rmhm(2017), doi:10.1016/j.ijrmhm.2017.09.010

Microstructure evolution and formation of needle-like WO_3 nanowire during sintering of submicron tungsten particles

M. Ahangarkani*, K. Zangeneh-madar, S. Borji

Department of materials and fabrication, Malek ashtar University of Technology, Tehran, Iran.

*Corresponding author: meysam_ahangar@ yahoo.com, Tel:+9822945141

Abstract

In this study, an interesting phenomenon was observed related to sintering of tungsten sub-micron powders in hydrogen atmosphere. Initial tungsten compacts containing 80wt.% micro powder and 20wt.% submicron particles (size of 100-600nm) were sintered in hydrogen atmosphere. SEM, XRD and EDS analysis were used to studying the micro-structural details. The obtained results exhibited an interesting oxidation-condensation phenomenon in sintered specimens that resulted into formation of needle-like WO_3 nanowires on the particle surfaces. Also, submicron particles accelerate the sintering of tungsten powders due to faceted-nonfaceted transformation mechanism. The obtained results proposed that oxygen content in initial powders can be considered as required oxygen source for nucleation and growth of WO_3 nano-structure. In this condition, the nanowires extend via solid-phase growth from nanowire nuclei generated on the W particles surface.

Keywords: tungsten; sintering; submicron; oxidation, nanowire.

1. Introduction

Due to high melting point of tungsten, powder metallurgy as well as sintering is a prefered approach for fabrication of tungsten parts [1]. Sintering process of tungsten skeleton carried out in hydrogen atmosphere. The obvious advantage of using hydrogen is its capability to reduce oxides [2]. Sintering in a controlled atmosphere helps to maintain or control the carbon and oxygen content of the material, by maintaining a certain level of active oxygen which is considered to be the oxygen potential of the sintering atmosphere.

Tungsten is processed by sintering at temperatures below their melting points and full sintered density can be achieved when temperatures as high as 2700°C are employed [3]. There are different approaches to improve the sinter-ability of tungsten. One is by the addition of small amount of transition metals such as Ni and Pd as activators, which can beneficially enhance the sintering kinetics of tungsten powder and thus reduce its sintering temperatures [4,5]. The other approach is by particle size refinement [6]. Mechanically activated sintering as well as surface activated sintering was summarized in this approach. The ultra-high energy method of milling was found to be critical to the sinter ability of the powder [7]. It has been demonstrated by Tolochko et.al[8] work that additions of up to 25 weight percent of nano