

Accepted Manuscript

Ferri-para-magnetism of tungsten and its carbide cermets for elevated temperature sensor application

Swe-Kai Chen() , Bo-Wen Jou() , Yeu-Tiing Tsai()

PII: S0577-9073(17)31130-9
DOI: [10.1016/j.cjph.2017.12.011](https://doi.org/10.1016/j.cjph.2017.12.011)
Reference: CJPH 412



To appear in: *Chinese Journal of Physics*

Received date: 6 September 2017
Revised date: 10 December 2017
Accepted date: 11 December 2017

Please cite this article as: Swe-Kai Chen() , Bo-Wen Jou() , Yeu-Tiing Tsai() , Ferri-para-magnetism of tungsten and its carbide cermets for elevated temperature sensor application, *Chinese Journal of Physics* (2017), doi: [10.1016/j.cjph.2017.12.011](https://doi.org/10.1016/j.cjph.2017.12.011)

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Ferri-para-magnetism of tungsten and its carbide cermets for elevated temperature sensor application

Swe-Kai Chen (陳瑞凱), Bo-Wen Jou (周伯衡), Yeu-Tiing Tsai (蔡宇挺)

Center for Nanotechnology, Materials Science, and Microsystems

National Tsing Hua University

101 Kuang-Fu Rd. Sec. 2, Hsinchu 30013, Taiwan, ROC

In routinely analyzing experimental results of low-temperature, $5\text{ K} \leq T \leq 300\text{ K}$, magnetic susceptibility $\chi(T)$ of fused tungsten and its fused carbide cermets, hereafter called “the materials”, by assuming the susceptibility satisfying the Néel ferrimagnetic formula, $\chi^{-1} = \chi_0^{-1} + \chi_1^{-1} + \chi_2^{-1}$, where χ_0^{-1} , χ_1^{-1} , and χ_2^{-1} are respectively the inverses of the Pauli paramagnetic, $\chi_0 > 0$, a Curie diamagnetic, $\chi_1 = C/T < 0$, and a lattice diamagnetic susceptibilities, $\chi_2 = (-1/b)(T - \Theta_p) < 0$, this study finds that the increase in susceptibility of the materials is principally due to the effect of the Curie diamagnetic term in the formula and might be caused by the demagnetizing field that is induced by the interstitial vacancy in, e.g., tungsten lattice. By extending the formula to the region of lower ($< 5\text{ K}$) and higher ($> 300\text{ K}$) temperatures, one finds two singular points in the susceptibility inverse curve χ^{-1} . One is at $\Theta_p < 0$, and the other $\Theta_a = -C/\chi_0 \gg 0$, e.g., $\Theta_p = -1.73\text{ K}$, and $\Theta_a = -C/\chi_0 = +8655\text{ K}$ for tungsten. In view of their susceptibility precisely satisfying the Néel ferrimagnetic formula **in the temperature range of 5 K and 300 K**, they are called “ferri-para-magnetism” and are good for elevated temperature sensor application **if the temperature extension is satisfied**. As temperature exceeding an asymptotic temperature, Θ_a , the paramagnetic state turns to a diamagnetic state, suggesting that there might be a superconducting transition at this temperature for some of the materials with Θ_a s that are lower than their melting points, e.g., $\Theta_a(\text{C7M1}) = +2735\text{ K}$ and $\Theta_a(-\text{VC}) = +2242\text{ K}$.

Keywords: ferri-para-magnetism (FPM); the Curie diamagnetism; lattice diamagnetism; the Pauli paramagnetism; demagnetizing field; interstitial vacancy; singular point; sensor; asymptotic temperature; superconducting

I. INTRODUCTION

Tungsten has a melting point (m.p.) of 3410°C that is next to 4027°C , the m.p. of carbon.¹ It is a good electrical conductor with resistivity of $4.96\text{--}5.3\ \mu\Omega\cdot\text{cm}^{2-3}$ at 300 K . The paramagnetic susceptibility of tungsten, at 298 K and at an applied magnetic

Download English Version:

<https://daneshyari.com/en/article/8145226>

Download Persian Version:

<https://daneshyari.com/article/8145226>

[Daneshyari.com](https://daneshyari.com)