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ANALYTICAL CHALLENGE

Solution to highest melting point challenge

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Solution

The phrase "$HfTa_4C_5$ has the highest melting point of any known material: 4215 °C" has become ingrained in textbooks, yet it is faulty because of a simple unit-conversion error.

In 1930 Agte and Alterthum determined the melting point of a mixed carbide 4TaC+1HfC compound to be "4215 in °abs", which is 4215 K [1]. Because of a confusion in reporting units this was reported as 4215 °C, and this value proliferates throughout the literature to this day. The original value in degrees Celsius is, of course, 3942 °C; but this value must be treated with some reservation because of the difficult experimental problems when dealing with this most refractory substance, which were not overcome until the 1960s in the laboratories at the Aerojet General Corporation in California.

In the 1960s it was established that the melting points of the tantalum and hafnium carbides were not highest for stoichiometric composition, i.e. $TaC_{1.00}$ and $HfC_{1.00}$. In fact, nonstoichiometric tantalum carbide at $TaC_{0.88}$ had a melting point of 3983±15 °C [2] and hafnium carbide at $HfC_{0.94}$ had a melting point determined as 3928±20 °C [3], which was later corrected to 3950±20 °C [4] to account for zirconium impurities in the original hafnium used to prepare the carbides.

Rudy [5] revealed that $TaC_{0.88}$ and $HfC_{0.94}$ were completely soluble in each other, and formed intermediate melting points trending linearly from the one pure compound to the other from 3928 °C to 3983 °C with no higher melting point for mixed carbides, in contradiction to Agte and Alterthum. Values of 4050 °C determined by Samsonov and Paderno [6] and 3990 °C by Andrievskii et al. [7] may also have anticipated a peak at 4TaC+1HfC, but the quality of these measurements must be queried because of the extreme experimental difficulties which existed, meaning that incorrect temperature corrections may have been applied when converting observed temperatures to true temperatures.

It is clear that the current value given throughout the literature for this most refractory substance is incorrect, and ought to be corrected to nonstoichiometric tantalum carbide, $TaC_{0.88}$, at 3983±20 °C.

This article is the solution to the Analytical Challenge to be found at http://dx.doi.org/10.1007/s00216-015-8564-y

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