Preface

This book consists of 11 chapters and presents a mostly not previously published review and critical analysis of past and present studies on carbon at very high temperatures. The author tried, to some extent, to preserve the temporal sequence of a very heterogeneous set of experiments and to group them around what he considers as key issues.

The book begins with general considerations on graphite and diamond. This introduction is followed by a description of the first attempts to melt graphite, since 1911, and to produce artificial diamonds.

In Chap. 2, experimental facts (obtained by A. Cezairliyan) about the electric resistance of graphite and its heat capacity in solid phase up to 3000 K are discussed. Knowledge of these properties has been the key to rational attempts to measure the triple point of carbon, at which the three phases coexist: solid, liquid and gaseous state. Then, the numerous attempts to reliably obtain the triple point of carbon are described in Chap. 3.

The experiments of F. Bundy (USA) and S. Lebedev (Russia) to record the melting area are discussed in Chap. 4. The results of pulse milliseconds heating of graphite and pulse microseconds heating are compared. It is claimed that the heating time, from seconds to microseconds, does not affect the obtained results for the melting temperature of carbon. Experimental studies of the scientists (M. Sheindlin and A. Kirillin; A. Cezairliyan; G. Pottlacher and R. Hixon) of the melting temperature and emissivity are compared to each other. The difficulties in measuring melting point under laser heating are mentioned.

Stationary studies (by L. Buchnev et al.) of the properties of graphite in the solid phase up to 3800 K, as well as calculations up to 4900 K are presented in the Chap. 5 to emphasize the importance of steady state research at a high professional level. The results of these experiments are in good agreement with pulse heating experiments.

In Chap. 6, milliseconds experiments (M. Togaya) at high pressures (up to 94 kbar), and microseconds pulse heating (G. Gathers et al. and J. Shaner; V. Korobenko and A. Savvatimskiy) without temperature measurements, are listed.

Their interpretation gives properties of liquid carbon as a function of input energy only. However, these results allowed to determine the appearing of the liquid phase and to obtain a non-trivial dependence of resistance at high pressure.

The experimental setup for pulse heating experiments is reviewed in Chap. 7. This material is extremely important to experimenters for further development of research methods for carbon at high temperatures. Pulse heating results on measuring carbon temperature (up to 12,000 K) are shown.

The ultimate goal of all of these experiments is to reliably develop a phase diagram of carbon. The history of the construction, over decades, of the phase (P-T) diagram of carbon (including modified diagram for nanocarbon) is discussed in Chap. 8. Modeling of carbon phase diagram and the agreement with the experiments are discussed, including the new publications of 2014–2015 years.

Chapter 9 displays the results of recent experiments (J. Eggert, G. Collins et al. USA) with carbon at extreme parameters: pressure level of millions bar and temperatures of about 10^4 K.

Chapter 10 is devoted to the study of graphene at high temperature (based on A. Balandin investigations). Graphene usually does not contain defects and impurities. This chapter does not only discuss graphene at temperatures of practical use (300–1000 K) but also gives the data on the melting of a Graphite HAPG (with the minimum defects) under pulse heating. In the last experiments in the year 2015, the melting temperature of the Graphite HAPG equals 4900 K, which coincides with the value for bulk carbon UPV-1T (HOPG graphite).

Moscow Alexander Savvatimsky

http://www.springer.com/978-3-319-21349-1

Carbon at High Temperatures

Sawatimskiy, A.

2015, XVII, 246 p. 136 illus., 20 illus. in color.,
Hardcover
ISBN: 978-3-319-21349-1