Preface to the special issue on metallic materials for fusion applications

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Tungsten as a refractory metal shows attractive and promising thermal properties at high temperatures such as the high melting point and the high thermal conductivity. In a nuclear fusion environment, tungsten is a favorable material because of its thermal properties as well as the good resistance to particle erosion, neutron irradiation, and tritium retention. The major concern using a tungsten wall is the radiative cooling of fusion plasma by tungsten impurities. A positive answer to this concern is the operation of Axially Symmetric Divertor Experiment-upgrade (ASDEX-U), a full tungsten Tokamak achieved in 2007. Its experiments show good compatibility of the tungsten wall with H-mode plasmas and various heating methods. The experimental advanced superconducting Tokamak (EAST) has been under operation using tungsten monoblocks with active cooling capability as the upper divertor since 2015, which provides strong technological support for the tungsten application in International Thermonuclear Experimental Reactor (ITER), the largest Tokamak under construction. The story would end here if tungsten could satisfy everything. The present challenge is the microstructural evolution of tungsten in extreme environments. The databases of tungsten properties in irradiated conditions (especially by fusion neutrons) are largely unknown. Considering other conditions of high temperature, high stress and intense particle implantation, tremendous challenges and opportunities are present in this field.

This special topic issue includes computational contributions of radiations effects in tungsten and technological contributions of tungsten and related materials for fusion devices, consisting of five review papers and two research articles. Two contributions are about the neutron

radiation effect in tungsten, one of which evaluated six interatomic potentials for tungsten in radiation damage simulations, and the other reviewed the theoretical advances in exploring radiation resistance of nano-structured tungsten at across scales. For radiation effects by plasma, the surface damage/microstructures and their effects on hydrogen and helium retention in tungsten were reviewed. Technological contributions include the recent development of thick tungsten coating prepared by atmospheric pressure chemical vapor deposition (APCVD) from Xiamen Tungsten Co., Ltd and Southwestern Institute of Physics in China, and the tungsten technology development for the upgrade of the Korea Superconducting Tokamak Advanced Research (KSTAR) in Korea. Two research articles are about nuclear-related technology. Liquid tin and capillary porous sieve (CPS) were studied using high-density argon plasmas. The dissimilar metal bonding between carbide dispersion-strengthened vanadium alloy by joining with conventional V-4Cr-4Ti alloy by hot isostatic pressing was described and characterized.

We hope this issue could display clear pictures of what we know and do not know to our dear readers, thus arouse enthusiasm for further investigations. Finally, we want to thank all the authors, reviewers, editors, and publishing staff for their efforts to the publication of this issue.

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