Synthesis and Characterization of Type II Si Clathrate Film

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Research Outline

Type II Clathrate film preparation and application in practical device

Introduction:

Inorganic clathrates of group 14 elements have been actively investigated to realize the inherent promising features such as unique photoelectric and thermoelectric properties etc. Type II Si and Ge clathrates act as a common choice for such realization. In recent years, the guest free Si clathrate has been considered as a promising material for optoelectronic or photovoltaic devices instead of diamond structure Si due to its direct band gap nature and the gap energy potentially tuned by alloying with Ge. Type II Ge clathrate and Si clathrate have been widely investigated by researchers all across the globe. However, the present reports are mainly from the powder form and realization in the film form deemed necessary for in-depth analysis of optical and electrical properties as well as real device applications. Few authors reported the films of type II Ge and Si clathrates but containing a lot of surface defects such as cracks in the microstructure analysis which makes it difficult to distinguish the information originating from the material itself and not perturbed by defect states present inside.

Synthesis method:

Type II Si and Ge clathrate film fabrication mainly involves deposition of amorphous Ge or Si film on the sapphire substrate using RF sputtering followed by reacting with Na in high vacuum and concurrent or subsequent annealing under high vacuum. Sample handling is performed in a dry Ar filled glove box.

Research progress:

Recently, we have developed a new technique in our research group to synthesize high quality type II Ge clathrate film and type II Si doped Ge clathrate film with improved surface quality suitable enough for in-depth analysis of electrical and optical properties. Furthermore, preliminary work for the synthesis of type II Si clathrate film is currently ongoing in our research group. Our main goal includes the realization of practical device applications such as light emitting diode and photovoltaic solar cells to assess their efficacy for practical device applications.

Our research group is actively involved in research collaborations within Japan such as Gifu University, Ibaraki University as well as overseas such as Indian Institute of Technology Guwahati, India and Central University of Jharkhand, India.

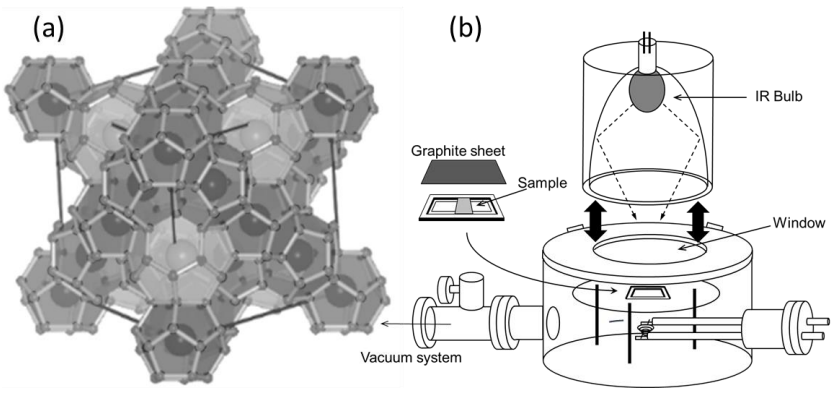

Fig. 1 (a) Crystal structure of type II clathrate (b) Vacuum chamber for the sample preparation.