Carbon Material as Refractory

1. Introduction

Carbon materials are important refractory materials for high-tech industries because they can withstand high temperatures (they do not melt), impurities can easily be removed, they are almost devoid of thermal expansion, and so on.This paper briefly describes the main uses for carbon materials and their reasons.

2. Semiconductor-related Fields

(1) Silicon semiconductor

The equipment for manufacturing single crystals of silicon operates at a higher temperature than the melting point of silicon (about 1,400℃). Therefore, the furnace material must have an even higher melting point and must not contain significant amounts of impurities. Since carbon materials can withstand high temperatures and impurities can be removed relatively easily, it is used for the heater, the susceptor that supports the quartz pot used to melt silicon, and the heat insulator, etc. (see **Fig. 1**).

In recent years, the diameters of single crystals of silicon used for semiconductors have increased to as large as 300 mm. Ways of increasing the diameter still further are also being studied. In order to mass-produce high performance semiconductors economically, it is necessary to improve the carbon material characteristics required of the furnace.

(2) Compound semiconductors

In terms of compound semiconductors, there are GaAs semiconductors used for mobile communication devices, and GaN semiconductors used for light-emitting diodes (LEDs) and laser diodes (LDs), etc. The use of compound semiconductors is ever expanding. The development of SiC semiconductors to easily control large electrical currents is also under way.

In terms of the equipment used to manufacture single crystals and compound semiconductor devices, high-purity carbon material is used for the heater, susceptor and heat insulator for the same reasons as mentioned in (1).

3. Solar Cell-related Fields

Increased attention is being paid to solar cells as a means of saving energy and curbing global warming. Accordingly, the production of solar cells is increasing rapidly. At present, solar cells using a single crystal or poly-crystal of silicon are the mainstream. Carbon material is used in the manufacturing of silicon as a raw material for solar cells (this silicon is not as pure as the silicon used for semiconductors) and in the manufacturing of single crystals and poly-crystals of silicon for solar cells for the same reasons as mentioned in Section 2.

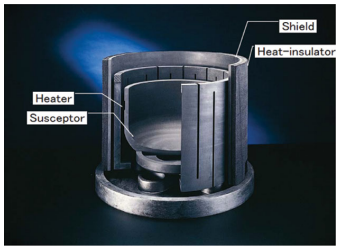

Fig. 1 Outline of single crystal manufacturing equipment

4. Quartz Product-related Fields

In the field of semiconductors, many quartz products are used for receptacles and jigs. Quartz is also used in the manufacturing of optical fibers for communications. All those products are required to have a high degree of purity. Manufacturing them calls for a high-purity material which can withstand high temperatures (1,500℃ or higher) and which does not contain significant amounts of impurities. Because of this, carbon material is used for the furnace and jigs.

5. Potential for Carbon Materials

The surfaces of recoverable space vehicles, such as the Space Shuttle, are covered with a heat-insulating carbon material to protect the vehicle body from the intense heat that occurs on reentry. Carbon material is also used for the nozzles of rockets that must be capable of withstanding the extremely hot jet gas.

At present, carbon material is not used in any of the light-water cooled reactors that are in operation in Japan. However, a hot gas furnace is being developed as a multipurpose reactor for power generation, hydrogen production, etc. In this reactor, carbon material which can withstand high temperatures and which has excellent dimensional stability is used for the moderator, reflector and other reactor structures.

6. Conclusion

Herein, we have briefly described carbon materials which play an important role on the sidelines, mainly in the high-tech fields that are attracting increasing attention of late.

In order to meet the brisk demand for carbon materials, Nippon Techno-Carbon Co., Ltd. and other makers of carbon specialties are expanding production capacity remarkably.

References

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