MECHANICAL PROPERTIES OF UNIDIRECTIONALLY REINFORCED MATERIALS*

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ABSTRACT

Mechanical properties of unidirectionally reinforced composite materials with the systematic variation of reinforcement and matrix have been studied aiming at standardization of materials, testing methods and developing advanced materials. Mechanical properties on identical materials were measured at three different laboratories independently and the results were compared each other.

The variation of mechanical properties originated from reinforcement, epoxy matrix and the deviation of data caused by different experimental method is discussed. The possibility of standardization and development of advanced materials are also discussed.

INTRODUCTION

Composite materials show a variety of fracture mode which leads to the large scatter of mechanical properties. This intrinsic nature of composite materials is originated from the compositeness and/or heterogeneity of their internal structure. This is the reason why the close investigation is required in practical application of composite

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materials. Furthermore, a number of components exist as reinforcement and/or matrix. Various compositing processes can be employed. Consequently, the standardization of composite materials has not been established yet, though some attempts have been made (Problem 1).

The testing method of composite materials has not been established yet. Since especially fiber reinforced plastics demonstrates size effects and deformation mode and/or deformation rate dependence, it is difficult to compare materials each other or to accumulate data for design based on one certain method. The establishment of testing method has to be done urgently (Problem 2).

In the development of advanced materials, the materials should be manufactured in identical method and conditions. The measurement should be done on the specimen with identical dimension using identical method, in order to clarify the merits and demerits of the new materials compared with usual ones. In other words, the standardization of materials and testing method can be thought as the first step in the development of advanced materials. From this viewpoint, the standardization should be an urgent task for the development of better composite material (Problem 3).

Japanese three groups have cooperatively been dealing with the standardization of composite materials used in cryogenic temperatures. Unidirectionally reinforced composite materials were prepared with Pultrusion method on the line of the standardization manufacturing process to obtain materials with same quality. The specimens were made by one manufacturer in order to minimize the scatter of properties. Concerning the testing method, each group has made the experiment under a certain specified condition which is varied systematically from group to group. The results were compared each other aiming at the establishment of better testing method. The possibility of development of advanced materials has been checked on the ceramics fiber reinforced plastics.

EXPERIMENTALS

In this work the results measured by three different groups on identical materials are shown. The mechanical test was basically three-point flexural test, and Young's modulus and breaking stress were calculated. Since each group made the experiment with different flexural speed and different jig. The effects of the flexural speed and the jig on results can be discussed.

Groups

The groups are Institute of Scientific and Industrial Research Osaka University (ISIR, including University of Osaka Prefecture), Research Reactor Institute Kyoto University (KUR) and Hoxan Cryogenic Technology Development Center (Hoxan). Each group made use of its characteristics, that is, Hoxan made the specimen, ISIR summarized this work and KUR will study the reactor irradiation effects. The testing machines used by ISIR, KUR and Hoxan are Shimazu universal testing machine RS, Shimazu Autograph universal testing machine AG-500A and Instron universal testing machine 1125, respectively (refer to Table 4).

Sample

We made it a rule to use the commercially available components. Hoxan made the sample. The samples are unidirectionally reinforced