Chapter 1. Introduction

INTERGLAD is the International Glass Database System developed and first released in 1991 by the New Glass Forum (NGF). INTERGLAD Ver. 7 is the latest information system for glasses; it contains data on the properties and/or structural features of approximately 340,000 types of glasses. It is designed to enable users to easily extract and use a wide variety of information suited to their purposes. It also enables users to predict properties of glasses and to design glasses of new composition based on the collected data. The NGF expects that this new version will become a favorite resource of glass users and producers and will assist in the development of the glass industry as well as related fields and scientific pursuits.

1. History of INTERGLAD

Work on the realization of the INTERGLAD International Glass Database began in 1987, which was the year in which the NGF was established, as part of its international contribution program. A group composed of glass researchers from both domestic universities and companies, led by Dr. Itaru Yasui, then a Professor at the University of Tokyo, worked on the database project from system design to data collection for three years, with the cooperation of several major foreign glass companies and the Dainippon Printing Company.

A CD-ROM containing the database system was released in April 1991 as the world's first glass database[1]. The original collected data encompassed approximately 100,000 glass compositions, and the input of data continued to the point of 120,000 compositions in Ver. 2, which was released in 1993, and 150,000 compositions in Ver. 3, which was released in 1996.

Until Ver. 3, the database could be run only on the MS-DOS operating system, using a CD-ROM. With the release of Ver. 4 in 1999, it became possible to access the database on either a CD-ROM or the Internet, using Windows, Macintosh, and Unix operating systems coupled with browser software. The Internet version was developed by the Toppan Printing Company[2]. Additional data were added to the Internet version each year, with the number of glass compositions reaching 180,000 by autumn of 2000.

The system's functioning was greatly enhanced with the release of Ver. 5 in 2001. Besides improvements made to the registration function, data analysis, composition/property prediction obtained by multiple regression analysis[3] and additivity equations, and user data registration functions were added; these additions greatly improved the features offered by the database and the convenience of users. These developments were achieved with the support of the Ministry of Economy, Trade and Industry in cooperation with the Fujitsu Co.

INTERGLAD Ver. 6 was developed from the end of 2002 to 2004 in cooperation with the Database Promotion Committee chaired by then Prof. Rikuo Ota of Kyoto Institute of Technology with the support of the Mizuho Information & Research Institute, Inc. This enterprise was part of the Research and Development to Promote the Creation and Utilization of an Intellectual Infrastructure

program of the New Energy and Industrial Technology Development Organization (NEDO). Throughout the project, the focus was upon high reliability for both the data and system sides of INTERGLAD, with data being systematically reviewed[4] and continually corrected as needed. In the multiple regression analysis, a regression equation without a constant[5] was added. In addition, an applet version that could be used without installing the program on the user's computer was added for increased user convenience in November 2005.

From July 2005 to March 2007, the NGF developed a prototype of the world's first glass structure database[6] related tools. This development was proceeded in cooperation with the Glass Structure Database Committee chaired by Professor Hiroyuki Inoue of the University of Tokyo as part of the Research and Development to Promote the Creation and Utilization of an Intellectual Infrastructure program of NEDO. The developed database of glass structures, which included factors such as interatomic distance, bond angle, ring structure, and coordination number was integrated into the newly released INTERGLAD Ver. 7 in 2009 (in Japan) and in 2010 (worldwide). Moreover, a multiple regression analysis tool with multiple polynomials[7], a data interpolation tool that can determine high temperature properties with few data, and a periodic table for easy component selection during searches, etc. were included in Ver. 7. This version was also developed with the support of the Mizuho Information & Research Institute, Inc.

As shown in Fig. 1, each year, new data have been added to INTERGLAD. Currently (May 2018), INTERGLAD contains data for 341,000 types of glasses in total.

INTERGLAD has been used for the development of new types of glass, such as low dispersion glass[8] and lead-free crystal glass[9], patent surveys related to glass composition, research into glass properties, searches in the field of research on new glass composition, and the development of new glass products. INTERGLAD has clearly played an important role in the development of the glass industry and glass research around the world.

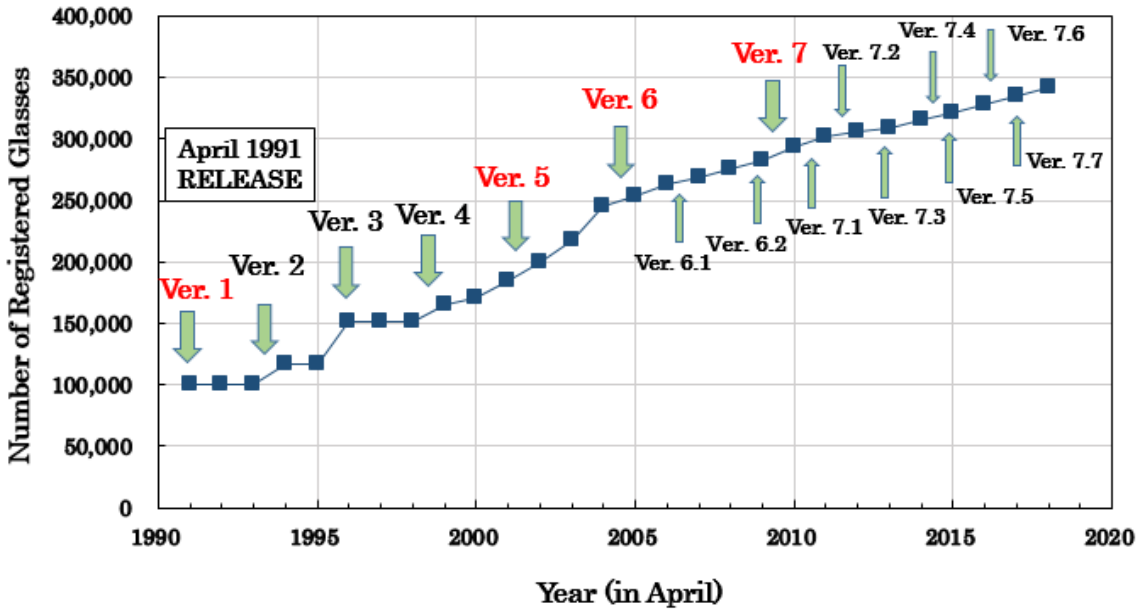

Fig. 1 Successive Versions and Data Renewal of INTERGLAD.

2. New Features and Improvements of INTERGLAD Ver. 7

1) Integrated glass structure database

The world's first database of glass structure information such as interatomic distance, bond angle, coordination number, bridging oxygen information, and oxidation number has been developed and integrated into INTERGLAD.

Although it still includes few registered structure data (10,000 glasses, May 2018), it is easy to search for the structural data for various compositions of glass and to analyze them well, which makes it possible to investigate the relationships among composition, properties, and structure. This is expected to contribute to the development of new glasses.

Ver. 7 is composed of a glass property database and a glass structure database. These databases have different entrances, but they are merged together internally.

2) Evolved multiple regression analysis for properties

A multiple regression analysis tool with multiple (quadratic or cubic) polynomials has been included. It is able to use not just one-component terms, but also two- or three-component terms as explanatory variables. This is effective for predicting the properties of many glasses for which additivity is not indicated. Assistance dialogues have also been prepared to facilitate easier prediction. Responses to Question messages and corrections to Error messages can be performed semiautomatically for easier analysis (from Ver. 7. 2).

3) Temperature-property plotting

When a dataset for a given glass includes the property data at different temperatures, a temperature-property XY plot can be drawn. The density, surface tension, thermal conductivity, etc. can all be applied to such a plot.

4) Easier selection of ternary plot condition (from Ver. 7. 2)

All selections of conditions for a ternary plot such as 3 components and property can be done in the [Ternary Plot] window, and the ternary plot changes instantaneously.

5) Selection of axis condition, marker shape and color in figures

The labels, value ranges and formats of values for axes of XY plots can be specified. The marker shapes and colors of plot points can be selected for XY plots and partly ternary plots. (marker shape and color: from Ver. 7.4)

6) Multi-selection of data source (from Ver. 7. 3)

As a search condition, 4 data sources (categories) can be selected. To specify relationships among the selected data sources, AND, OR or NOT can be selected for each data source.

7) Data interpolation tool

Using the interpolation (extrapolation) tool, property values can be calculated for given temperatures without fact data. The obtained data can also be used in multiple regression analysis. This tool is effective for the analysis of high temperature properties with few data.

The object properties that can be calculated include density, Young's modulus, surface tension, specific heat, thermal conductivity, viscosity, electric conductivity, electric resistance, dielectric loss,

etc.

8) Easier search tools

A Simple Search Window that offers only composition and property columns as search conditions is now offered in addition to the conventional Full Search Window.

A new Periodic Table Small Window has also been included to make it easier to select components as the conditions of composition.

A key-word input tool makes selection of composition, property, appearance, feature & process, usage, data source, etc. easier to search for.

Any item of each category of appearance, feature & process and usage can be used as search condition. (from Ver. 7.5)

9) Increased and improved additivity equations

An equation for thermal conductivity proposed by Ammar[10] has been added. The composition ranges that enable one to perform calculations could be widened to accommodate nine equations and could be appropriately narrowed for one equation. Three equations for standard point of viscosity and an equation for electrical conductivity both proposed by Fluegel have been added (from Ver. 7.3).

10) Extended print and save functions

The printing of glass information from a Data Source Window, file saving from the multiple regression analysis window, image saving of the prediction result, etc. are now possible.

11) Tool bars and menu bars

All the program's functions are indicated on the tool bars, and frequently used items are accessible via icons on the menu bars.

12) CD-ROM Full Function Edition

The full function edition of INTERGLAD is also usable with a PC that is not connected to the web. When this edition is used, there is no possibility of invasion by a third party, which makes it practical and secure, particularly the user database.

13) Enhanced User Data function

The user definitions of glass codes and property names are free.

14) System speed-up

Complicated searches (with plural NOTs, etc.) are completed more quickly.

15) Continued registration of new data and improved reliability

New property data for 6,000–8,000 types of glasses are registered each year, as are data corrections for over 1,000 glasses. In addition, the volume of structural data is steadily and continually increased.

16) Renewed user's manual

Basic visual procedures for various purposes have been prepared (Chapter 3) and the ID lists have been also renewed. Examples of use have been revised and enlarged to 26 examples (in 2012).

The user's manual is regularly updated in PDF and the latest PDF manual can be referenced and downloaded on the INTERGLAD web page at any time (for annual contract users).

17) The latest INTERGLAD system

The latest INTERGLAD system can be used in an Internet Edition at any time. The Standard Edition of the INTERGLAD system, which is renewed each year, can be downloaded from our web page simply by inputting a User ID and Password.

18) System Renewal

The system has been totally renovated to be compatible with the latest OS, Browser, and Java environment.

References

1 Y. Suzuki, Am. Ceram. Soc. Bull., 70 (1991) 219.

2 T. Saitou, H. Oguro, T. Fukami, T. Iseda, Proceedings of the Japan Society of Information and Knowledge, May 1999, p.63.

3 I. Yasui, F. Utsuno, Am. Ceram. Soc. Bull., 72 (1993) 65.

4 T. Iseda, Y. Iwasa, S. Yoshida, T. Kawasaki, Proc. XX-ICG (ICG, Sept. 2004) 07-029.

5 F. Utsno, H. Inoue, I. Yasui, S. Tsuboi, T. Iseda, Proc. XX-ICG (ICG, Sept. 2004) 07-030.

6 K. Suzuki, T. Iseda, H. Inoue, ICG2007, A36.

7 K. Suzuki, T. Iseda, H. Inoue, A. Masuno, PACRIM8-S23-P179-2009.

8 M. Fukuoka, H. Kinoshita, S. Noda, Y. Morita, J. Ceram. Soc. Jap., 110(2002), 1073.

9 H. Satha, M. Remram, J. Simons, Proceedings of the International Symposium on Glass Problems (ICG, Sept. 1996) p.193.

10 M. M. Ammer, S. A. Gharib, M. M. Halawa, H. A. El-Batal, K. El-Badry, Communications of American Ceramic Society, May 1983, C-76.

7 May, 2018