Chapter 3

Self-Diffusion in Alloys

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Additional information is available at the end of the chapter

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Abstract

It has been successfully provided that in Fe, Co, Ni, Cu, Zn, Al, Ga, Cr, and Mn, alloy has been done to obtain reliable values of diffusion coefficient particularly with Arrhenius relationship graphic plotter tool. In the presented work, the Arrhenius plots of self-diffusions and other diffusion mechanisms have been exemplified. It is an aim to summarize diffusion coefficients in Arrhenius relations that are important for physical constant values in specified materials via free-of-charge Web-based diffusion coefficient diffusion database.

Keywords: Diffusion coefficient, Arrhenius relation, Co, Ni, Cu, Zn, Al, Ga, Cr, Mn, Metal and alloy

1. Introduction

There has been considerable important work to investigate that seems to be a reliable value of diffusion coefficient and temperature dependences of diffusivity in all around alloy and composite because it would be an essential physical constant value in specified materials and vitally useful for material development [1,2]. Particularly coefficients for self-diffusion are the most essential and have shown to be a good base element for thermal property in bulk-forming alloy. But it is difficult to measure the self-diffusivity in materials and alloys basically because the measurement is impossible other than using radioisotope tracer. In the present work, the use of a drawing tool with Arrhenius relation plots and data analysis function has been applied to determine the relations of thermal property regarding numerical activation energies and pre-exponential factors (frequency factors) and to evaluate whether it represents several Arrhenius relation platforms focusing on the developing materials [3]. Additionally, Web-based diffusion coefficient database presented the NIMS, National Institute for Materials Science, Japan, on October 10, 2014, including 8,925 diffusion data and 4,242 references which

needed to be registered. They said that the diffusion database aims to cover all the basic diffusion data that mainly targeted metallic and inorganic materials and substantially contains information of pure metals, alloys, semiconductors, ceramics, and intermetallics [4].

The main objective of this research is to provide a diffusion data in alloys as well as a usage of Web-based diffusion database platform from all over the world to present diffusion research results and development activities in materials science. Additionally, to clarify a self-diffusion among alloys to develop for explorer thermal property using the process of plotting diffusion coefficient and temperature dependence, Arrhenius relations in alloy and composite all around the world focusing on the activation energy and pre-exponential factor discussion by using Web-based diffusion coefficient database-presented NIMS have been shown clearly in specially using freeware GP.exe plotting tool [3]. This discussion focusing on activation energy for diffusion coefficient in a relationally atomic diffusivity was able to investigate perspectives regarding discussed numerical values. Moreover, in activation energies for diffusion coefficient within all alloys, a quantity alloy development in materials has been discussed with the use of total relationship plots in Arrhenius relations that depend on diffusion temperature.

2. Procedure

Suitable for Arrhenius relation plots and data analysis, even a spreadsheet software and database relationally atomic diffusivity including the MIMS are good procedures among references of treatise for Arrhenius relation plot data and diffusion coefficients. Consequently, in the failure of searching the database, the term of an activation energy narrowing can prevent the error and be able to avoid limitation of MIMS database owing to be less than 100 results. Using freeware GP.exe plotting tool is a respectable way to discuss the activation energy and pre-exponential factor of Arrhenius relation diffusivity in alloys.

In Figure 1, the schematic diffusion coefficient tendency of 84 data alloys is related with the diffusion Web database list of MIMS, especially in Fe alloy system and with diffusant of Fe through handmade relational data-based processing by using the so-called presented work AWK-GP-PDF drawing system with GP.exe [5, 6, 7] where PDF means the Portable Document Format which the Adobe Systems Incorporated (ADBE) developed. It was found that using the AWK-GP drawing system made clear the relations between the T-inverse and T-linear value. Additionally, the D shows the extrapolated D_0 strongly related among the Q and T; diffusion mechanism and thermodynamics easily show the nearly neighbored equilibrium alloy state even if it does not understand the diffusivity in objective-based alloy. The certain overall atoms in an around alloy have a rule in the tendency of this AWK-GP-PDF drawing Arrhenius plot rather than in without the extrapolated D_0 relation. Subsequently symbol meanings are given below:

D: diffusion coefficient (m^2/s)

D_0: diffusion constant (pre-exponential factor, frequency factor) (m^2/s)

Q: activation energy (kJ/mol), (1 eV=96.5 kJ/mol)

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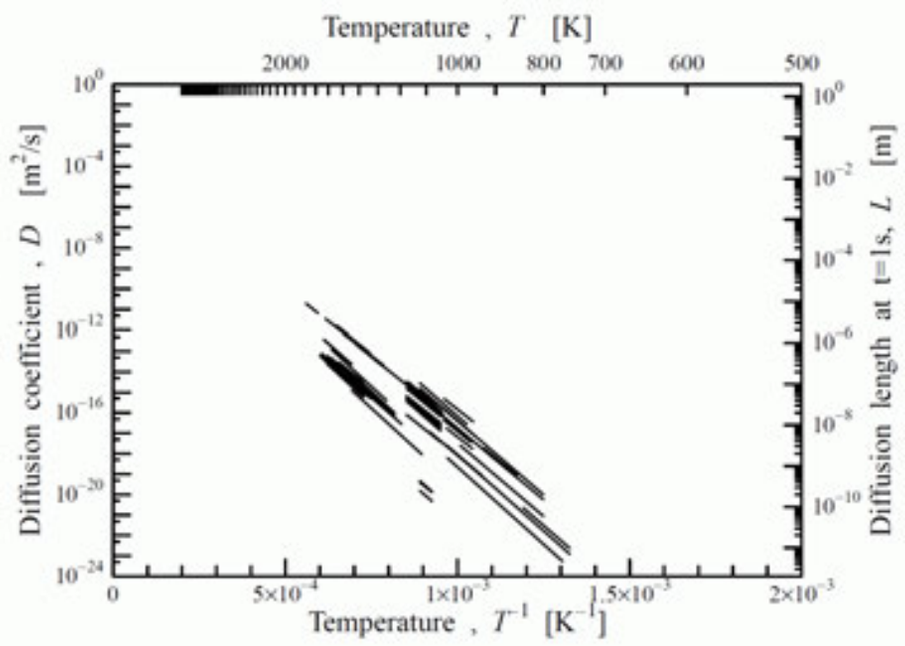

Figure 1. Schematic illustrations of Arrhenius plots for picked-up 84 data alloys between the activation energy of diffusion coefficient from 251 to 300 kJ/mol described with lower horizontal axes of temperature inversed, upper horizontal of linear temperature, left perpendicular axis of logarithm diffusion coefficient, and right perpendicular of logarithm diffusion length at time t=1 s, respectively

R: gas constant=8.31446 (J/mol K)

T: absolute temperature (K)

t : diffusion time (s)

And regarding Figure 1 diffusion data, in the minimum and maximum range of *T* during the diffusion process, the temperature dependence of diffusivity *D* available among references of treatise is shown below:

$$D = D_0 \exp\left(-\frac{Q}{RT}\right) \tag{1}$$

And in diffusion length [2], *L* means in general as

$$L = 2\sqrt{Dt} = 2\sqrt{D},\ at\ t = 1s. \tag{2}$$

In alloy development, the characteristics of the objective alloy from analysis of neighboring information of nearly alloy systems and diffusant can be predicted. Because it is difficult to obtain new experimental diffusivity, the superior study by analogy with well-known data can be modified.

It may be concluded that the AWK-GP-PDF system with NIMS diffusion database presented one of the superior level prediction processes in the world using the nearest-neighbor diffusion characteristics for user objective developing alloys.

2.1. Process with AWK: An interpreted programming language

AWK [8] which was created at Bell Labs in the 1970s is an interpreted programming language design of ASCII, abbreviated from American Standard Code for Information Interchange, for data processing and typically used as a data extraction and reporting tool. It is now presented in Unix-like operating systems, although its platform has that of Windows OS, Mac OS, and Linux OS unfluctuating on Android OS.

Result: 67

F1: D=D0*exp(-Q/RT)

Material	Diffusant	D_0 [m^2/s]	Q [kJ/mol]	Tmin [K]	Tmax [K]
Fe-Ni	Fe;Ni	2.00E-05	264	1123	1699
Fe-Ni	Fe;Ni	1.50E-05	263	978	1699
Fe-Ni	Fe;Ni	1.74E-05	272	1383	1699
Fe-Ni	Fe;Ni	2.60E-05	262	978	1699
Fe-Ni	Fe;Ni	3.00E-05	259	978	1699
Fe-Ni	Fe;Ni	3.80E-05	257	978	1699
Fe-Ni	Fe;Ni	4.10E-05	255	978	1699
Fe-Ni	Fe;Ni	5.60E-05	255	978	1699
Fe-Ni	Fe;Ni	7.10E-05	256	978	1699
Fe-Ni	Fe;Ni	6.30E-05	255	978	1699
Fe-Co	Fe;Co	1.50E-07	219	1273	1673
Fe-Co	Fe;Co	7.85E-08	198	1273	1673
Fe-Co	Fe;Co	2.90E-07	215	1273	1673
Fe-Co	Fe;Co	2.07E-07	205	1273	1673
Fe-Co	Fe;Co	4.40E-07	212	1273	1673
Fe-Co	Fe;Co	5.80E-07	216	1273	1673
Fe-Co	Fe;Co	7.00E-07	215	1273	1673
Fe-Co	Fe;Co	8.80E-07	217	1273	1673
Fe-Co	Fe;Co	1.15E-06	218	1273	1673
Fe-Co	Fe;Co	1.20E-06	218	1273	1673
Fe-Co	Fe;Co	1.31E-06	219	1273	1673

Figure 2. Schematic search tendency of 67 data alloy jointed diffusant list; relational database for alloy diffusivity using method limiter by activation energy values, e.g. material, Fe-based alloy; diffusant, Fe. Reference from NIMS database, using clipboard pasted and related with spreadsheet software, e.g., MS Excel would be highly user friendly

In Figure 2, the schematic search tendency of color-coded 67 data (only the top 21 are illustrated in Figure 2) jointed diffusant list (column 3), pre-exponential factor D_0 (column 4), activation energy Q (column 5), and minimum and maximum temperature for Arrhenius relation's linear function span (columns 6 and 7), respectively. It should be rearranged in formula F1 (in Figure

2) as $D=D_0$ exp (-Q/RT); then in MS Excel formula, "=[cell#3]*EXP(-1*[cell#4]*1000/8.31429/[cell#5]) " and "=[cell#3]*EXP(-1*[cell#4]*1000/8.31429/[cell#6])," D_{min} and D_{max}, would be adapted, respectively.

As shown later summarized afterward AWK script make into the 3 lines of reformation CSV (comma-separated values) or space-separated value (3 lines cycled) formation for optimize into the GP.exe data format, as shown in Table 1.

The AWK, process in Figure 3, a sample AWK script for calculation and reforming suitable for GP.exe data format as filename data01.TXT is shown in Table 1. Now for adequate usage to be a reasonable AWK script, it should be named with filename ex2gp.awk and then a command line that is executable in circumstances and command as gawk –f ex2gp.awk exceldata.txt > data01.TXT should be used. For example, it is the Windows OS GNU that is a Unix-like computer operating system developed by the GNU Project tool of gawk.exe for interpreting awk script as a multi-byte version of GNU awk 3.1.5 modified for Windows OS including interactive pipe and Internet correspondence with supporting character code Shift_JIS, EUC-JP, and UTF-8. On the other hand, in Mac OS and Linux, replacement of the only gawk name should be able to bring effect on the above command line script.

Regarding the before-mentioned "exceldata.txt," in Figure 4, a typical numerical example for copied-and-pasted text file for Arrhenius relations plots datasheet is shown. In Figure 4, [tab] means a Tab key (abbreviation of tabulator key or tabular key) on a computer keyboard. Meanwhile, on the computer screen, [tab] would be usually invisible. It is only necessary for the display of the Arrhenius relation plots of awk fields 1, 2, 3, and 4 as to be $1, $2, $3, and $4. But additionally, it would be useful for the other field of so-called code in awk $0 that means fully one line information from the start to the end.

Additionally in Figure 5, a sample batch file script for the AWK script exaction is shown. For adequate usage to be a reasonable script, the filename should be ex2gp.bat in Windows OS. After the main processing in ex2gp.bat, e.g., in the second half, a text editor Terapad.exe should be used for recognition. Other free text editors should be replaced, for example, the Emacs, etc.

2.2. Process with GP.exe

As AWK exploited technicalities to process the data, data01.TXT shown in Table 1 has been created. Then the next would be plotting the Arrhenius relation graph as horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via diffusion mechanism for discussion infinity T of D_0.

For plotting the Arrhenius relationship, the freeware in Tohoku University, by Prof. K. Edamatsu, GP.exe that was designed until 1999 to make smart graphs for publication with powerful data analysis ability such as numerical complex differentiation and comparison was used. And now it is shown that the GP.exe has been useful for genuine data processing even in the year 2015. Fortunately, GP.exe is now supported with DOS, Disk Operating System, emulator and being executed GP.exe on it. Presented tutorials show a freeware DOSBox that is DOS emulator enabled on platform of Windows OS, Mac OS, and Linux OS including Android OS. After it has been difficult in general to calculate and plot numerical T inverse and

D logalism between any kinds of diffusion data and temperature, the freeware GP.exe tutorial to short-course calculation and plotting method will be provided in this session.

x-axis data y-axis data	
A main title of presented Graph	
A title of x-axis	
A title of y-axis	
#Comment No.01	
956	**3.63977E-17**
1041	**4.94613E-16**
#Comment No.02	
956	**8.45635E-18**
1041	**1.59639E-16**
#Comment No.03	
800	**8.75231E-22**
992	**2.53967E-18**
#Comment No.04	
1386	**2.67551E-15**
1528	**2.07494E-14**
.	.
.	.
.	.
.	.

Table 1. Typical numerical example for Arrhenius relation plots and lines as the special suitable format for GP.exe as data filename data01.TXT. It is necessary for instructions to include the filename within length of 8 and 3, because of the software of legacy-type DOS. The header of 3 lines are the main title, x-axis title, and y-axis title, respectively. In addition, more than 1 blank line makes an effect of snapping regarding the continuous line of GP.exe drafting

In Figure 6, a schematic illustration of DOSBox of DOS emulator and executed GP.exe as platform on its DOSBox is shown. The left and right windows are the prompt and main frame of DOSBox emulator, respectively. GP.exe users have to add DOSBox configuration descriptions as in Figure 7 for GP.exe executable circumstances via DOSBox application menu for configurations. Additionally, GP.exe have to read firstly the initial file of INIT.GPR file as Figure 8 for easy reading the data file data01.TXT and further adding useful extra properties.

Furthermore, Figure 7 has shown the menu of "DOSBox 0.74 Options," a sample configuration script for [autoexec] area; it should be necessary to add the MOUNT and Change-Directry and then execute the GP.exe. If the user needs to use the Japanese keyboard, then the line "keyb

jp" should be added and also its module. In case of English keyboard, it is not needed. In the case of GP.exe, the current directory might be C:/prog/gp/GP.exe.

2.3. Plot confirmation and characterization with GP.exe

If the cases that the [autoexec] area execution might be started, or in DOSBox command line "gp" followed "enter" key in to the graph plot tool GP.exe start, it would be started GP.exe opening. In Figure 8, the standard INIT.GPR file for GP.exe was shown, and one point modified description included as colored red and underlined "*.TXT". For example, if the user needs to use a "data01.TXT" in the presented case, the user firstly should change from "*.xy" to "*.TXT" in the [Path and Directories] DataPath of INIT.GPR that is a good way to easy mounting data such as "data01.TXT".

Meanwhile, in Figure 9, Arrhenius relationship plot profile file is shown in detail, and descriptions of Figure 9 are explained below.

For example, on the other "data01.TXT" as shown in Table 1, 4 kinds of linear Arrhenius relations are conformed; the user can display computer graphics on graph plot tool GP.exe, finally resulting as in Figure 10 through high-resolution PostScript and PDF format.

On graph plot tool GP.exe, first of all, it is best that the user of the Arrhenius plot use not "INIT.GPR" but "ARRHEN.GPR" in the beginning as shown in Figure 9. In this figure, the use of tool extraction of freeware df.exe and schematic illustration of differences between "ARRHEN.GPR" and "INIT.GPR" for executable parameters on graph plot tool GP.exe were shown. The "INIT.GPR" is completely similar as in the list in Figure 8. On the other hand, "ARRHEN.GPR" has a file of "data01.txt" that have 4 groups of data as shown in Table 1 and 4 groups of linear line in Arrhenius relationship plotting on temperature T inverse and legalism D value as shown in Figure 10.

Regarding GP.exe plot confirmation and characterization in Figure 11, GP.exe schematic illustrations for searching the plots and their points, which plots for 4 groups of linear line in Arrhenius relationship plotting on temperature inverse and legalism D value, are represented. That is, there are 8 edges of the right and left on the 4 linear lines. The graph plot tool GP.exe has the superior function that can show the accurate value of data as shown in Figure 11 of green-colored cross-grid. Data points from relational database for alloy diffusivity using clipboard pasted and related with spreadsheet software were concluded, and then data were delivered on GP.exe by suitable optimized processing using AWK into the GP.exe format.

2.4. Process with GP.exe into postscript file

In Figure 12, schematic illustrations on the graph plot tool GP.exe, for creating the high-resolution PostScript picture as shown in Figure 11, which file of 01.ps for common forms of Arrhenius plots using GP.exe. If the user wants to reproduce the similar frame of Arrhenius plots but with another diffusion data, the data should be replaced with (filename from the data01.TXT to another filename, e.g., data02.TXT) the *.GPR graph parameter file. Meanwhile, the user can transform precisely from 01.ps to 01gw.pdf (PDF: Portable Document Format) using the freeware command line tool Ghostscript.

2.5. Process with PDF graphic file

Using the freeware command line tool Ghostscript, the user can transform PS to PDF. Then the user can use another freeware, Adobe Reader or Adobe Acrobat Reader. In Figure 13, Adobe reader schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) picture as all pictures shown are presented. When using those of freeware PDF reader, the user opens the PDF of 01gw.pdf, sets the magnitude to "400 %," activates "Take a Snapshot," chooses the "Select All," and finally chooses the "Copy." All through the process, the user could copy the graphic data onto the Windows OS, Mac OS, and Linux OS clipboard.

2.6. Process with GIF, JPEG, PNG, etc., graphic file

In Figure 14, it will be a pair of image processing software schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) picture as all pictures shown are presented in this paper. For example, using the freeware "IrfanView," the user opens the menu "Save Picture As" of clipboard picture data and pastes it by "Paste Ctrl+V," and the user can copy and paste through the graphic Windows OS clipboard examples. Finally, almost 94 kByte of compact-size and high-resolution GIF file was created via the software "IrfanView." This high-resolution GIF file of around 94 kByte would be user friendly for making documentation with graphic pictures. Also the other standard graphic file formats of JPEG, PNG, BMP, TIF, etc., are able to apply in a similar procedure the high-performance software "iView."

```
# ex2gp.awk
BEGIN{
# adding 3 lines for GP.exe standard graph configuration format as *.GPR
printf("A main title of presented Graph\n");
printf("A title of x-axis \n");
printf("A title of y-axis \n");
}

{
i++;  # Data numbering
printf("#%s\n",$0); # Marking data and comment one by one for
relationship between excel and GP text data.
printf("%s  %s\n",$1,$3);
printf("%s  %s\n\n\n",$2,$4); # It was acquired two empty lines following
diffusion data for easiness in seeing.
#$1 is Tmin [K]
#$3 is D(Tmin) [m^2/s]
#$2 is Tmax [K]
#$4 is D(Tmax) [m^2/s]
}

END{
printf("%d  are now re-arranged.\n",i)>"/dev/stderr";
}
```

¶(4pt)

Figure 3. A sample AWK script for calculation and reforming suitable for GP.exe data format as filename data01.TXT shown in Table 1. The AWK script should be a name as filename ex2gp.awk and then command line executable circumstances as gawk.exe -f ex2gp.awk excldata.txt > data01.TXT For example, it is the Windows OS GNU that is a Unix-like computer operating system developed by the GNU Project tool of gawk.exe for interpreting awk script as multi-byte version of GNU awk 3.1.5 modified for Windows OS including interactive pipe and Internet correspondence with supporting character codes Shift_JIS, EUC-JP, and UTF-8

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¶(6pt)

```
956[tab]1041[tab]3.63977E-17[tab]4.94613E-16[tab][tab]Fe[tab][tab]Fe55;Fe59[tab]2.75E-
        03[tab]254[tab]956[tab]1041[tab][tab]3.64E-17[tab]4.95E-16
956[tab]1041[tab]8.45635E-18[tab]1.59639E-16[tab][tab]Fe[tab][tab]Fe55;Fe59[tab]3.58E-
        02[tab]286[tab]956[tab]1041[tab][tab]8.46E-18[tab]1.60E-16
```

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Windows OS GNU that is a Unix-like computer operating system developed by the GNU Project tool of gawk.exe for interpreting awk script as multi-byte version of GNU awk 3.1.5 modified for Windows OS including interactive pipe and Internet correspondence with supporting character codes Shift_JIS, EUC-JP, and UTF-8

¶(6pt)

```
956[tab]1041[tab]3.63977E-17[tab]4.94613E-16[tab][tab]Fe[tab][tab]Fe55;Fe59[tab]2.75E-
       03[tab]254[tab]956[tab]1041[tab][tab]3.64E-17[tab]4.95E-16
956[tab]1041[tab]8.45635E-18[tab]1.59639E-16[tab][tab]Fe[tab][tab]Fe55;Fe59[tab]3.58E-
       02[tab]286[tab]956[tab]1041[tab][tab]8.46E-18[tab]1.60E-16
800[tab]992[tab]8.75231E-22[tab]2.53967E-18[tab][tab]Fe[tab][tab]Fe59[tab]6.80E-
       04[tab]274[tab]800[tab]992[tab][tab]8.75E-22[tab]2.54E-18
1386[tab]1528[tab]2.67551E-15[tab]2.07494E-14[tab][tab]Fe[tab][tab]Fe59[tab]1.00E-
       05[tab]254[tab]1386[tab]1528[tab][tab]2.68E-15[tab]2.07E-14
   .          .
   .          .
```

Figure 4 Typical numerical example for copied-and-pasted text file as name exceldata.txt

Figure 4. Typical numerical example for copied-and-pasted text file as name exceldata.txt Arrhenius relations plots and lines MS Excel. In this figure, the [tab] means a Tab key (abbreviation of tabulator key or tabular key) on a keyboard. It is only necessary for the display of the Arrhenius relation plots of awk fields 1, 2, 3, and 4 as to be $1, $2, $3, and $4

Arrhenius relations plots and lines MS Excel. In this figure, the [tab] means a Tab key (abbreviation of tabulator key or tabular key) on a keyboard. It is only necessary for the display of the Arrhenius relation plots of awk fields 1, 2, 3, and 4 as to be $1, $2, $3, and $4

```
gawk  -f  ex2gp.awk  exceldata.txt  >  data01.TXT
pause
TeraPad\TeraPad.exe  data01.TXT
exit
```

¶(6pt)

Figure 5 A sample Batch File script for the AWK script exaction. Filename should be ex2gp.bat. After the main processing, in the second half, it should be used with a text editor as Terapad.exe after recognition. Other free text editors should be replaced, for example, the Emacs

Figure 5. A sample Batch File script for the AWK script exaction. Filename should be ex2gp.bat. After the main processing, in the second half, it should be used with a text editor as Terapad.exe after recognition. Other free text editors should be replaced, for example, the Emacs

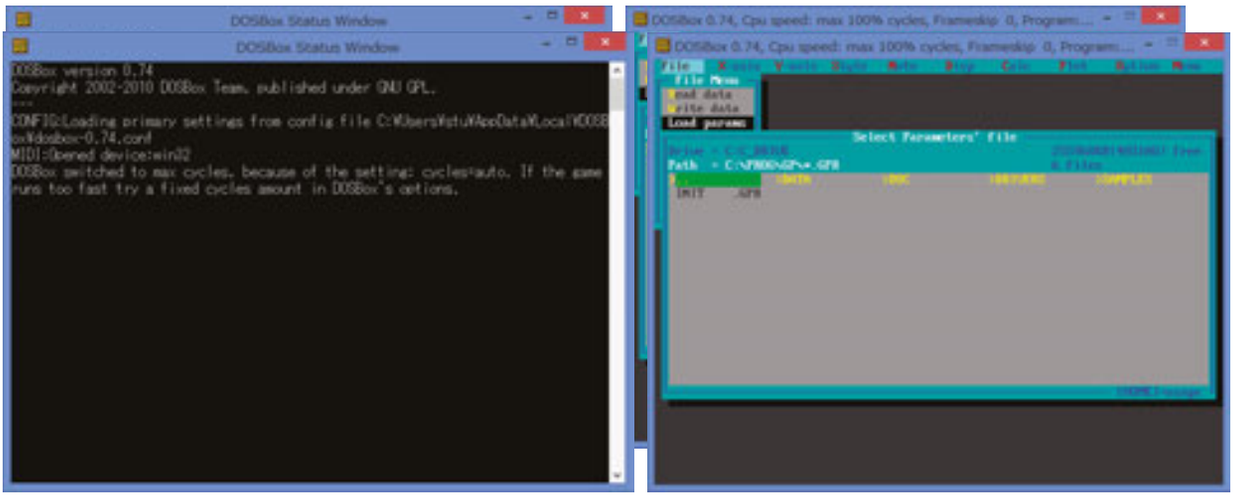

Figure 6 Schematic illustration of DOSBox of DOS emulator and executed GP.exe as platform on its DOSBox. The left and right windows are the prompt and main frame of DOSBox emulator, respectively. GP.exe users have to add configuration descriptions as in Figure 7 for GP.exe executable circumstances. Additionally, GP.exe has to read firstly the initial file of INIT.GPR file as in Figure 8 for easy reading the data file data01.TXT and furthermore adding useful extra properties

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```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.
@ECHO OFF
```

Figure 6 Schematic illustration of DOSBox of DOS emulator and executed GP.exe as platform on its DOSBox. The left and right windows are the prompt and main frame of DOSBox emulator, respectively. GP.exe users have to add configuration descriptions as in Figure 7 for GP.exe executable circumstances. Additionally, GP.exe has to read firstly the initial file of INIT.GPR file as in Figure 8 for easy reading the data file data01.TXT and furthermore adding useful extra properties

```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.
@ECHO OFF
MOUNT c C:\
c:
CD \prog\gp
keyb jp
gp
```

Figure 7 DOSBox 0.74 Options.txt a sample configuration script for [autoexec] area, should be necessary to add the MOUNT and Change Directry and then execute the GP.exe. If the user needs to use the Japanese keyboard, then the line "keyb jp" should be added and also its module. In the case of GP.exe, the current directory might be C:/prog/gp/GP.exe

Figure 7. The figure of "DOSBox 0.74 Options.txt a sample configuration script for [autoexec] area, should be necessary to add the MOUNT and Change Directry and then execute the GP.exe. If the user needs to use the Japanese keyboard, then the line "keyb jp" should be added and also its module. In the case of GP.exe, the current directory might be C:/prog/gp/GP.exe

```
GraphP parameters file
version 4.31

[Remarks]
*** You can put remarks here
***


[Hardware Parameters]

PrinterType
 2
HdcopyType
 1
PlotterPort
 3
RSparams
 2 7 2 2 0 0
ParallelPort
 2
PlotSpeed
 0
PlotColors
 8
PlotterDriver
DRIVERSWPS.DLL

Beep
 0


[Text Colors]

TextColorSet
 1


[Graphic Colors]

GraphicColorSet
 1
WindowPaneColor
 2
AnalogColors ($GRB)
 $000 $FFF $1F1 $00F $F22
$FF2 $0BF $F0F $333 $999 $0A
$00A $A00 $AA0 $0AA $A0A


[File Selecter Switches]

DisplaySwitch
W

SortSwitch
N



[Special Menus]
```

```
XaxisTrans
 0


[Data Sizes]

MaxNData
 1000
MaxNFiles
 9
NScales
 5
NNotes
 10
NCaptions
 9
NArrows
 10


[Data Form]

TitleLineNo
 1
XlabelLineNo
 2
YlabelLineNo
 3
DataHeadLineNo
 4
ColumnStrings
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE
X, Y, YE



[Path and Directories]

DataPath
*.TXT

ParamPath
*.GPR

PlotPath
*.PS

DriverPath
*.DLL

LogPath
*.LOG
```

```
[Data Files]

NumberOfFiles
 0
FileNames



[Overlay Files]

NumberOfFiles
 0
FileNames



[Plot File Parameters]

PlotterPort
 3
PlotFileName
01.PS



[Plot Sizes]

PlotForm
 2
FormSize
 0 210 0 297
PlotArea
 30 170 20 120
PlotMag
 100 100


[Axis Parameters]

AxisSw
 1 1 0 0 2 2
AxisLabel
X-AXIS
Y-AXIS




AxisFunction
 0 0 0 0 0 0
AxisPower
 1 1 1 1 1 1
AxisMin
 0 0 0 0 0 0
AxisMax
 10 10 10 10 10 10
AxisPosition
 0 0 0 0 0 0
AxisAutoScale
```

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```
 1 1 1 1 0 0


[Axis Scales]

AxisTick
 1 0 0 0 0 1 0 0 0 0 1 0 0
0 1 0 0 0 0 0 0 0 0 0 0 0 0
0
AxisSubTick
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
AxisNum
 2 0 0 0 0 2 0 0 0 0 2 0 0
0 2 0 0 0 0 0 0 0 0 0 0 0 0
0
AxisGrid
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
AxisMin
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
AxisMax
 10 0 0 0 0 10 0 0 0 0 10 0
0 0 10 0 0 0 0 0 0 0 0 0 0
0 0 0
AxisNumStyle
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0
0


[Aixs LogScales]

LogTick
 1 1 1 1 1 1
LogNum
 2 2 2 2 2 2
LogGrid
 0 0 0 0 0 0
AxisNumStyle
 0 0 0 0 0 0


[Axis Options]

FrameColor
 1 1 1 1 1 1
TickColor
 1 1 1 1 1 1
TickLength
 2 2 2 2 2 2
TickAngle
 90 -90 -90 90 90 -90
NumColor
 1 1 1 1 1 1
NumFont
 0 0 0 0 0 0
NumDistance
 0 0 0 0 0 0
NumAngle
 -90 90 90 -90 -90 90
NumWidth
 1 1 1 1 1 1
NumHeight
 4 4 4 4 4 4
NumSpace
 0 0 0 0 0 0
LabelColor
 1 1 1 1 1 1
LabelFont
 0 0 0 0 0 0
LabelDistance
 0 0 0 0 0 0
LabelAngle
 -90 90 90 -90 -90 90
LabelWidth
 1 1 1 1 1 1
LabelHeight
 5 5 5 5 5 5
LabelSpace
 0 0 0 0 0 0
LabelPosition
 50 50 50 50 100 100
GridColor
 1 1 1 1 1 1
GridLength
 100 140 100 140 0 0
GridAngle
 90 -90 -90 90 90 -90
GridStyle
 2 2 2 2 2 2
GridPeriod
 1 1 1 1 1 1


[Data Operators]

DataZero
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
DataPower
 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1
DataMag
 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1
DataShift
 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
DataMin
 -3.4E+38 -3.4E+38 -3.4E+38
3.4E+38 -3.4E+38 -3.4E+38 -
3.4E+38 -3.4E+38 -3.4E+38 -
3.4E+38 -3.4E+38 -3.4E+38 -
3.4E+38 -3.4E+38 -3.4E+38 -
3.4E+38 -3.4E+38 -3.4E+38
DataMax
 3.4E+38 3.4E+38 3.4E+38
3.4E+38 3.4E+38 3.4E+38
3.4E+38 3.4E+38 3.4E+38
3.4E+38 3.4E+38 3.4E+38
3.4E+38 3.4E+38 3.4E+38
3.4E+38 3.4E+38 3.4E+38
DataSmooth
 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
DataAxis
 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
DataClip
 3 3 3 3 3 3 3 3 3 3 3 3 3 3
3 3 3 3


[File Operators]

FileOprator
 0 0 0 0 0 0 0 0 0
FileObject
 0 0 0 0 0 0 0 0 0


[MathFunction Operators]

CalcSwitch
 0 0 0 0 0 0 0 0 0
AutoRange
 1 1 1 1 1 1 1 1 1
ParamRange
 0 10 1 0 10 1 0 10 1 0 10 1
0 10 1 0 10 1 0 10 1 0 10 1 0
10 1
Xfunction
x
x
x
x
x
x
x
x
x

Yfunction
y
y
y
y
y
y
y
y
y


[Math Variables]


[Fitting Parameters]

FitFunctions
```

```
InitialParams
 0

Range
 -3.4E+38 3.4E+38 -3.4E+38
3.4E+38


[Differentiation Parameters

Orders
 0 0 0 0 0 0 0 0 0


[Integration Parameters]

FileNumber
 0
Range
 -3.4E+38 3.4E+38


[Sort Parameters]

Orders
 0 0 0 0 0 0 0 0 0


[Mark Styles]

MarkColor
 1 2 3 4 5 6 7 8 0
MarkType
 0 0 0 0 0 0 0 0 0
MarkSize
 2 2 2 2 2 2 2 2 2


[Error-bar Styles]

ErrorBarColor
 1 2 3 4 5 6 7 8 0
ErrorBarType
 1 1 1 1 1 1 1 1 1
ErrorBarSize
 1 1 1 1 1 1 1 1 1


[Bar Styles]

BarColor
 1 2 3 4 5 6 7 8 0
BarType
 0 0 0 0 0 0 0 0 0
BarSize
 0 0 0 0 0 0 0 0 0


[Line Styles]

LineColor
 1 2 3 4 5 6 7 8 0
LineType
 1 2 3 4 5 6 7 1 1
LineSize
 0 1 2 3 10 15 15 0 0
Spline
 0 0 0 0 0 0 0 0 0


[Arrow Styles]

ArrowColor
 1 1 1 1 1 1 1 1 1
ArrowType
 0 0 0 0 0 0 0 0 0
ArrowSize
 2 2 2 2 2 2 2 2 2
ArrowX1
 0 0 0 0 0 0 0 0 0
ArrowY1
 90 80 70 60 50 40 30 20 10
ArrowX2
 10 10 10 10 10 10 10 10 10
10
ArrowY2
 90 80 70 60 50 40 30 20 10
LineType
 1 1 1 1 1 1 1 1 1
LineSize
 0 0 0 0 0 0 0 0 0


[Note Styles]

NoteColor
 1 1 1 1 1 1 1 1 1
NoteFont
 0 0 0 0 0 0 0 0 0
NoteRefPoint
 0 0 0 0 0 0 0 0 0
NoteX
 10 10 10 10 10 10 10 10 10
10
NoteY
 90 80 70 60 50 40 30 20 10
NoteWidth
 1 1 1 1 1 1 1 1 1
NoteHeight
 4 4 4 4 4 4 4 4 4
NoteSpace
 0 0 0 0 0 0 0 0 0
NoteDirection
 0 0 0 0 0 0 0 0 0
NoteStrings


[Caption Styles]

CaptionColor
 0 0 0 0 0 0 0 0 0
CaptionFont
 0 0 0 0 0 0 0 0 0
CaptionRefPoint
 0 0 0 0 0 0 0 0 0
CaptionX
 0 0 0 0 0 0 0 0 0
CaptionY
 150 145 140 135 130 125 120
115 110
CaptionWidth
 1 1 1 1 1 1 1 1 1
CaptionHeight
 4 4 4 4 4 4 4 4 4
CaptionSpace
 0 0 0 0 0 0 0 0 0
CaptionDirection
 0 0 0 0 0 0 0 0 0
CaptionStrings


[End of file]
```

Figure 8 The standard INIT.GPR file for GP.exe. If you need to use a data01.TXT, you should change from *.xy to *.TXT in the [Path and Directories] DataPath of INIT.GPR

Figure 8. The standard INIT.GPR file for GP.exe. If you need to use a data01.TXT, you should change from *.xy to *.TXT in the [Path and Directories] DataPath of INIT.GPR

```
ARRHEN.GPR                                        INIT.GPR
00001  |GraphP parameters file version 4.31       ||00001  |GraphP parameters file version 4.31
00002  |                                          ||00002  |
00003  |[Remarks]                                 ||00003  |[Remarks]
00004  |*** You can put remarks here. ***         ||00004  |*** You can put remarks here. ***
00005  |                                          ||00005  |
00006  |                                          ||00006  |
       |                                          ||00007 R|[Hardware Parameters]
       |                                          ||00008 R|
       |                                          ||00009 R|PrinterType
       |                                          ||00010 R| 2
       |                                          ||00011 R|HdcopyType
       |                                          ||00012 R| 1
       |                                          ||00013 R|PlotterPort
       |                                          ||00014 R| 3
       |                                          ||00015 R|RSparams
       |                                          ||00016 R| 2 7 2 2 0 0
       |                                          ||00017 R|ParallelPort
       |                                          ||00018 R| 2
       |                                          ||00019 R|PlotSpeed
       |                                          ||00020 R| 0
       |                                          ||00021 R|PlotColors
       |                                          ||00022 R| 8
       |                                          ||00023 R|PlotterDriver
       |                                          ||00024 R|DRIVERSWPS.DLL
       |                                          ||00025 R|
       |                                          ||00026 R|Beep
       |                                          ||00027 R| 0
       |                                          ||00028 R|
       |                                          ||00029 R|
       |                                          ||00030 R|[Text Colors]
       |                                          ||00031 R|
       |                                          ||00032 R|TextColorSet
       |                                          ||00033 R| 1
       |                                          ||00034 R|
       |                                          ||00035 R|
       |                                          ||00036 R|[Graphic Colors]
       |                                          ||00037 R|
       |                                          ||00038 R|GraphicColorSet
       |                                          ||00039 R| 1
       |                                          ||00040 R|WindowPaneColor
       |                                          ||00041 R| 2
       |                                          ||00042 R|AnalogColors ($GRB)
       |                                          ||00043 R| $000 $FFF $1F1 $00F $F22 $FF2 $0BF $F0F $333 $999
       |                                          ||00044 R|
       |                                          ||00045 R|
       |                                          ||00046 R|[File Selecter Switches]
       |                                          ||00047 R|
       |                                          ||00048 R|DisplaySwitch
       |                                          ||00049 R|W
       |                                          ||00050 R|
       |                                          ||00051 R|SortSwitch
       |                                          ||00052 R|N
       |                                          ||00053 R|
       |                                          ||00054 R|
       |                                          ||00055 R|
       |                                          ||00056 R|[Special Menus]
       |                                          ||00057 R|
       |                                          ||00058 R|XaxisTrans
       |                                          ||00059 R| 0
       |                                          ||00060 R|
       |                                          ||00061 R|
00007  |[Data Sizes]                              ||00062  |[Data Sizes]
00008  |                                          ||00063  |
00009  |MaxNData                                  ||00064  |MaxNData
00010 L| 16                                       ||00065 R| 1000
00011  |MaxNFiles                                 ||00066  |MaxNFiles
00012  | 9                                        ||00067  | 9
00013  |NScales                                   ||00068  |NScales
00014  | 5                                        ||00069  | 5
00015  |NNotes                                    ||00070  |NNotes
00016  | 10                                       ||00071  | 10
00017  |NCaptions                                 ||00072  |NCaptions
00018  | 9                                        ||00073  | 9
00019  |NArrows                                   ||00074  |NArrows
00020  | 10                                       ||00075  | 10
00021  |                                          ||00076  |
00022  |                                          ||00077  |
```

```
00023 |[Data Form]
00024 |
00025 |TitleLineNo
00026 | 1
00027 |XlabelLineNo
00028 | 2
00029 |YlabelLineNo
00030 | 3
00031 |DataHeadLineNo
00032 | 4
00033 |ColumnStrings
00034 |X, Y, YE
00035 |X, Y, YE
00036 |X, Y, YE
00037 |X, Y, YE
00038 |X, Y, YE
00039 |X, Y, YE
00040 |X, Y, YE
00041 |X, Y, YE
00042 |X, Y, YE
00043 |
00044 |
00045 |
00046 |[Path and Directories]
00047 |
00048 |DataPath
00049 L|*.TXT
00050 |
00051 |ParamPath
00052 |*.GPR
00053 |
00054 |PlotPath
00055 |*.PS
00056 |
00057 |DriverPath
00058 |*.DLL
00059 |
00060 |LogPath
00061 |*.LOG
00062 |
00063 |
00064 |
00065 |[Data Files]
00066 |
00067 |NumberOfFiles
00068 L| 1
00069 |FileNames
00070 L|DATA01.TXT
00071 |
00072 |
00073 |
00074 |[Overlay Files]
00075 |
00076 |NumberOfFiles
00077 | 0
00078 |FileNames
00079 |
00080 |
00081 |
00082 |[Plot File Parameters]
00083 |
00084 |PlotterPort
00085 | 3
00086 |PlotFileName
00087 |01.PS
00088 |
00089 |
00090 |
00091 |[Plot Sizes]
00092 |
00093 |PlotForm
00094 | 2
00095 |FormSize
00096 | 0 210 0 297
00097 |PlotArea
00098 | 30 170 20 120
00099 |PlotMag
00100 | 100 100
00101 |
00102 |
00103 |[Axis Parameters]
00104 |
00105 |AxisSw
00106 L| 1 1 1 1 2 2
00107 |AxisLabel
00108 L|Temperature , Wf[2]TWf[0]^{-1} [K^{-1}]
00109 L|Diffusion coefficient , Wf[2]DWf[0]  [m^2/s]
```

```
||00078 |[Data Form]
||00079 |
||00080 |TitleLineNo
||00081 | 1
||00082 |XlabelLineNo
||00083 | 2
||00084 |YlabelLineNo
||00085 | 3
||00086 |DataHeadLineNo
||00087 | 4
||00088 |ColumnStrings
||00089 |X, Y, YE
||00090 |X, Y, YE
||00091 |X, Y, YE
||00092 |X, Y, YE
||00093 |X, Y, YE
||00094 |X, Y, YE
||00095 |X, Y, YE
||00096 |X, Y, YE
||00097 |X, Y, YE
||00098 |
||00099 |
||00100 |
||00101 |[Path and Directories]
||00102 |
||00103 |DataPath
||00104 R|*.txt
||00105 |
||00106 |ParamPath
||00107 |*.GPR
||00108 |
||00109 |PlotPath
||00110 |*.PS
||00111 |
||00112 |DriverPath
||00113 |*.DLL
||00114 |
||00115 |LogPath
||00116 |*.LOG
||00117 |
||00118 |
||00119 |
||00120 |[Data Files]
||00121 |
||00122 |NumberOfFiles
||00123 R| 0
||00124 |FileNames
||       |
||00125 |
||00126 |
||00127 |
||00128 |[Overlay Files]
||00129 |
||00130 |NumberOfFiles
||00131 | 0
||00132 |FileNames
||00133 |
||00134 |
||00135 |
||00136 |[Plot File Parameters]
||00137 |
||00138 |PlotterPort
||00139 | 3
||00140 |PlotFileName
||00141 |01.PS
||00142 |
||00143 |
||00144 |
||00145 |[Plot Sizes]
||00146 |
||00147 |PlotForm
||00148 | 2
||00149 |FormSize
||00150 | 0 210 0 297
||00151 |PlotArea
||00152 | 30 170 20 120
||00153 |PlotMag
||00154 | 100 100
||00155 |
||00156 |
||00157 |[Axis Parameters]
||00158 |
||00159 |AxisSw
||00160 R| 1 1 0 0 2 2
||00161 |AxisLabel
||00162 R|X-AXIS
||00163 R|Y-AXIS
```

```
00110 L|Temperature , Wf[2]TWf[0]  [K]                 ||00164 R|
00111 L|Diffusion length at t=1s, Wf[2]LWf[0]  [m]     ||00165 R|
00112  |                                               ||00166  |
00113  |                                               ||00167  |
00114  |                                               ||00168  |
00115  |AxisFunction                                   ||00169  |AxisFunction
00116 L| 0 1 2 1 0 0                                   ||00170 R| 0 0 0 0 0 0
00117  |AxisPower                                      ||00171  |AxisPower
00118 L| -1 1 -1 1 1 1                                 ||00172 R| 1 1 1 1 1 1
00119  |AxisMin                                        ||00173  |AxisMin
00120 L| 0 1.0E-24 3.4E+38 2.0E-12 0 0                 ||00174 R| 0 0 0 0 0 0
00121  |AxisMax                                        ||00175  |AxisMax
00122 L| 0.002 1 500 2 10 10                           ||00176 R| 10 10 10 10 10 10
00123  |AxisPosition                                   ||00177  |AxisPosition
00124  | 0 0 0 0 0 0                                   ||00178  | 0 0 0 0 0 0
00125  |AxisAutoScale                                  ||00179  |AxisAutoScale
00126 L| 0 0 0 0 0 0                                   ||00180 R| 1 1 1 1 0 0
00127  |                                               ||00181  |
00128  |                                               ||00182  |
00129  |[Axis Scales]                                  ||00183  |[Axis Scales]
00130  |                                               ||00184  |
00131  |AxisTick                                       ||00185  |AxisTick
00132 L| 0.0001 0 0 0 0 1 0 0 0 0 100 0 0 0 0 1 0 0 0 0 0 ||00186 R| 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0
00133  |AxisSubTick                                    ||00187  |AxisSubTick
00134 L| 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 ||00188 R| 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00135  |AxisNum                                        ||00189  |AxisNum
00136 L| 0.0005 0 0 0 0 2 0 0 0 0 0 100 1000 0 0 2 0 0 0 0 0 ||00190 R| 2 0 0 0 0 2 0 0 0 0 2 0 0 0 0 2 0 0 0 0 0 0 0 0 0
00137  |AxisGrid                                       ||00191  |AxisGrid
00138  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 ||00192  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00139  |AxisMin                                        ||00193  |AxisMin
00140 L| -3.4E+38 0 0 0 0 -3.4E+38 0 0 0 0 100 100 1000 0 0 ||00194 R| 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00141  |AxisMax                                        ||00195  |AxisMax
00142 L| 3.4E+38 0 0 0 0 3.4E+38 0 0 0 0 5000 800 2000 0 0 0 ||00196 R| 10 0 0 0 0 0 10 0 0 0 0 0 10 0 0 0 0 0 10 0 0 0 0 0 0 0 0
00143  |AxisNumStyle                                   ||00197  |AxisNumStyle
00144 L| 2 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 ||00198 R| 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00145  |                                               ||00199  |
00146  |                                               ||00200  |
00147  |[Aixs LogScales]                               ||00201  |[Aixs LogScales]
00148  |                                               ||00202  |
00149  |LogTick                                        ||00203  |LogTick
00150 L| 1 5 1 1 1 1                                   ||00204 R| 1 1 1 1 1 1
00151  |LogNum                                         ||00205  |LogNum
00152 L| 2 10000 2 100 2 2                             ||00206 R| 2 2 2 2 2 2
00153  |LogGrid                                        ||00207  |LogGrid
00154  | 0 0 0 0 0 0                                   ||00208  | 0 0 0 0 0 0
00155  |AxisNumStyle                                   ||00209  |AxisNumStyle
00156 L| 0 2 0 2 0 0                                   ||00210 R| 0 0 0 0 0 0
00157  |                                               ||00211  |
00158  |                                               ||00212  |
00159  |[Axis Options]                                 ||00213  |[Axis Options]
00160  |                                               ||00214  |
00161  |FrameColor                                     ||00215  |FrameColor
00162  | 1 1 1 1 1 1                                   ||00216  | 1 1 1 1 1 1
00163  |TickColor                                      ||00217  |TickColor
00164  | 1 1 1 1 1 1                                   ||00218  | 1 1 1 1 1 1
00165  |TickLength                                     ||00219  |TickLength
00166  | 2 2 2 2 2 2                                   ||00220  | 2 2 2 2 2 2
00167  |TickAngle                                      ||00221  |TickAngle
00168  | 90 -90 -90 90 90 -90                          ||00222  | 90 -90 -90 90 90 -90
00169  |NumColor                                       ||00223  |NumColor
00170  | 1 1 1 1 1 1                                   ||00224  | 1 1 1 1 1 1
00171  |NumFont                                        ||00225  |NumFont
00172  | 0 0 0 0 0 0                                   ||00226  | 0 0 0 0 0 0
00173  |NumDistance                                    ||00227  |NumDistance
00174  | 0 0 0 0 0 0                                   ||00228  | 0 0 0 0 0 0
00175  |NumAngle                                       ||00229  |NumAngle
00176  | -90 90 90 -90 -90 90                          ||00230  | -90 90 90 -90 -90 90
00177  |NumWidth                                       ||00231  |NumWidth
00178  | 1 1 1 1 1 1                                   ||00232  | 1 1 1 1 1 1
00179  |NumHeight                                      ||00233  |NumHeight
00180  | 4 4 4 4 4 4                                   ||00234  | 4 4 4 4 4 4
00181  |NumSpace                                       ||00235  |NumSpace
00182  | 0 0 0 0 0 0                                   ||00236  | 0 0 0 0 0 0
00183  |LabelColor                                     ||00237  |LabelColor
00184  | 1 1 1 1 1 1                                   ||00238  | 1 1 1 1 1 1
00185  |LabelFont                                      ||00239  |LabelFont
00186  | 0 0 0 0 0 0                                   ||00240  | 0 0 0 0 0 0
00187  |LabelDistance                                  ||00241  |LabelDistance
00188  | 0 0 0 0 0 0                                   ||00242  | 0 0 0 0 0 0
00189  |LabelAngle                                     ||00243  |LabelAngle
00190  | -90 90 90 -90 -90 90                          ||00244  | -90 90 90 -90 -90 90
00191  |LabelWidth                                     ||00245  |LabelWidth
00192  | 1 1 1 1 1 1                                   ||00246  | 1 1 1 1 1 1
00193  |LabelHeight                                    ||00247  |LabelHeight
00194  | 5 5 5 5 5 5                                   ||00248  | 5 5 5 5 5 5
00195  |LabelSpace                                     ||00249  |LabelSpace
00196  | 0 0 0 0 0 0                                   ||00250  | 0 0 0 0 0 0
```

```
00197  |LabelPosition                                   ||00251  |LabelPosition
00198  | 50 50 50 50 100 100                            ||00252  | 50 50 50 50 100 100
00199  |GridColor                                       ||00253  |GridColor
00200  | 1 1 1 1 1 1                                    ||00254  | 1 1 1 1 1 1
00201  |GridLength                                      ||00255  |GridLength
00202  | 100 140 100 140 0 0                            ||00256  | 100 140 100 140 0 0
00203  |GridAngle                                       ||00257  |GridAngle
00204  | 90 -90 -90 90 90 -90                           ||00258  | 90 -90 -90 90 90 -90
00205  |GridStyle                                       ||00259  |GridStyle
00206  | 2 2 2 2 2 2                                    ||00260  | 2 2 2 2 2 2
00207  |GridPeriod                                      ||00261  |GridPeriod
00208  | 1 1 1 1 1 1                                    ||00262  | 1 1 1 1 1 1
00209  |                                                ||00263  |
00210  |                                                ||00264  |
00211  |[Data Operators]                                ||00265  |[Data Operators]
00212  |                                                ||00266  |
00213  |DataZero                                        ||00267  |DataZero
00214  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0            ||00268  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00215  |DataPower                                       ||00269  |DataPower
00216  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1            ||00270  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
00217  |DataMag                                         ||00271  |DataMag
00218  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1            ||00272  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
00219  |DataShift                                       ||00273  |DataShift
00220  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0            ||00274  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00221  |DataMin                                         ||00275  |DataMin
00222  | -3.4E+38 -3.4E+38 -3.4E+38 -3.4E+38 -3.4E+38 -3.4||00276  | -3.4E+38 -3.4E+38 -3.4E+38 -3.4E+38 -3.4E+38 -3.4
00223  |DataMax                                         ||00277  |DataMax
00224  | 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3||00278  | 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3.4E+38 3
00225  |DataSmooth                                      ||00279  |DataSmooth
00226  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0            ||00280  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00227  |DataAxis                                        ||00281  |DataAxis
00228  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0            ||00282  | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
00229  |DataClip                                        ||00283  |DataClip
00230  | 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3            ||00284  | 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
00231  |                                                ||00285  |
00232  |                                                ||00286  |
00233  |[File Operators]                                ||00287  |[File Operators]
00234  |                                                ||00288  |
00235  |FileOprator                                     ||00289  |FileOprator
00236  | 0 0 0 0 0 0 0 0 0                              ||00290  | 0 0 0 0 0 0 0 0 0
00237  |FileObject                                      ||00291  |FileObject
00238  | 0 0 0 0 0 0 0 0 0                              ||00292  | 0 0 0 0 0 0 0 0 0
00239  |                                                ||00293  |
00240  |                                                ||00294  |
00241  |[MathFunction Operators]                        ||00295  |[MathFunction Operators]
00242  |                                                ||00296  |
00243  |CalcSwitch                                      ||00297  |CalcSwitch
00244 L| 1 0 0 0 0 0 0 0 0                              ||00298 R| 0 0 0 0 0 0 0 0 0
00245  |AutoRange                                       ||00299  |AutoRange
00246  | 1 1 1 1 1 1 1 1 1                              ||00300  | 1 1 1 1 1 1 1 1 1
00247  |ParamRange                                      ||00301  |ParamRange
00248 L| 0.002 0.0001 -0.0000095 0 10 1 0 10 1 0 10 1 0 10||00302 R| 0 10 1 0 10 1 0 10 1 0 10 1 0 10 1 0 10 1 0 10 1
00249  |Xfunction                                       ||00303  |Xfunction
00250 L|1/x                                             ||00304 R|x
00251  |x                                               ||00305  |x
00252  |x                                               ||00306  |x
00253  |x                                               ||00307  |x
00254  |x                                               ||00308  |x
00255  |x                                               ||00309  |x
00256  |x                                               ||00310  |x
00257  |x                                               ||00311  |x
00258  |x                                               ||00312  |x
00259  |                                                ||00313  |
00260  |Yfunction                                       ||00314  |Yfunction
00261  |y                                               ||00315  |y
00262  |y                                               ||00316  |y
00263  |y                                               ||00317  |y
00264  |y                                               ||00318  |y
00265  |y                                               ||00319  |y
00266  |y                                               ||00320  |y
00267  |y                                               ||00321  |y
00268  |y                                               ||00322  |y
00269  |y                                               ||00323  |y
00270  |                                                ||00324  |
00271  |                                                ||00325  |
00272  |                                                ||00326  |
00273  |[Math Variables]                                ||00327  |[Math Variables]
00274 L|X =1163                                         ||       |
00275 L|X =1163                                         ||       |
00276 L|X =1163                                         ||       |
00277 L|X =1163                                         ||       |
00278 L|X =1163                                         ||       |
00279 L|X =1163                                         ||       |
00280 L|X =1163                                         ||       |
00281 L|X =1163                                         ||       |
00282 L|X =1163                                         ||       |
00283 L|X =1168                                         ||       |
```

```
00284 L|X =1528
00285 L|Y =N
00286  |
00287  |
00288  |
00289  |[Fitting Parameters]
00290  |
00291  |FitFunctions
00292  |
00293  |
00294  |
00295  |
00296  |
00297  |
00298  |
00299  |
00300  |
00301  |
00302  |InitialParams
00303  | 0
00304  |
00305  |Range
00306  | -3.4E+38 3.4E+38 -3.4E+38 3.4E+38
00307  |
00308  |
00309  |[Differentiation Parameters]
00310  |
00311  |Orders
00312  | 0 0 0 0 0 0 0 0 0 0
00313  |
00314  |
00315  |[Integration Parameters]
00316  |
00317  |FileNumber
00318  | 0
00319  |Range
00320  | -3.4E+38 3.4E+38
00321  |
00322  |
00323  |[Sort Parameters]
00324  |
00325  |Orders
00326  | 0 0 0 0 0 0 0 0 0 0
00327  |
00328  |
00329  |[Mark Styles]
00330  |
00331  |MarkColor
00332  | 1 2 3 4 5 6 7 8 0
00333  |MarkType
00334  | 0 0 0 0 0 0 0 0 0 0
00335  |MarkSize
00336  | 2 2 2 2 2 2 2 2 2
00337  |
00338  |
00339  |[Error-bar Styles]
00340  |
00341  |ErrorBarColor
00342  | 1 2 3 4 5 6 7 8 0
00343  |ErrorBarType
00344  | 1 1 1 1 1 1 1 1 1
00345  |ErrorBarSize
00346  | 1 1 1 1 1 1 1 1 1
00347  |
00348  |
00349  |[Bar Styles]
00350  |
00351  |BarColor
00352  | 1 2 3 4 5 6 7 8 0
00353  |BarType
00354  | 0 0 0 0 0 0 0 0 0 0
00355  |BarSize
00356  | 0 0 0 0 0 0 0 0 0 0
00357  |
00358  |
00359  |[Line Styles]
00360  |
00361  |LineColor
00362  | 1 2 3 4 5 6 7 8 0
00363  |LineType
00364  | 1 2 3 4 5 6 7 1 1
00365  |LineSize
00366  | 0 1 2 3 10 15 15 0 0
00367  |Spline
00368  | 0 0 0 0 0 0 0 0 0 0
00369  |
00370  |
||       |
||       |
||00328  |
||00329  |
||00330  |
||00331  |[Fitting Parameters]
||00332  |
||00333  |FitFunctions
||00334  |
||00335  |
||00336  |
||00337  |
||00338  |
||00339  |
||00340  |
||00341  |
||00342  |
||00343  |
||00344  |InitialParams
||00345  | 0
||00346  |
||00347  |Range
||00348  | -3.4E+38 3.4E+38 -3.4E+38 3.4E+38
||00349  |
||00350  |
||00351  |[Differentiation Parameters]
||00352  |
||00353  |Orders
||00354  | 0 0 0 0 0 0 0 0 0 0
||00355  |
||00356  |
||00357  |[Integration Parameters]
||00358  |
||00359  |FileNumber
||00360  | 0
||00361  |Range
||00362  | -3.4E+38 3.4E+38
||00363  |
||00364  |
||00365  |[Sort Parameters]
||00366  |
||00367  |Orders
||00368  | 0 0 0 0 0 0 0 0 0 0
||00369  |
||00370  |
||00371  |[Mark Styles]
||00372  |
||00373  |MarkColor
||00374  | 1 2 3 4 5 6 7 8 0
||00375  |MarkType
||00376  | 0 0 0 0 0 0 0 0 0 0
||00377  |MarkSize
||00378  | 2 2 2 2 2 2 2 2 2
||00379  |
||00380  |
||00381  |[Error-bar Styles]
||00382  |
||00383  |ErrorBarColor
||00384  | 1 2 3 4 5 6 7 8 0
||00385  |ErrorBarType
||00386  | 1 1 1 1 1 1 1 1 1
||00387  |ErrorBarSize
||00388  | 1 1 1 1 1 1 1 1 1
||00389  |
||00390  |
||00391  |[Bar Styles]
||00392  |
||00393  |BarColor
||00394  | 1 2 3 4 5 6 7 8 0
||00395  |BarType
||00396  | 0 0 0 0 0 0 0 0 0 0
||00397  |BarSize
||00398  | 0 0 0 0 0 0 0 0 0 0
||00399  |
||00400  |
||00401  |[Line Styles]
||00402  |
||00403  |LineColor
||00404  | 1 2 3 4 5 6 7 8 0
||00405  |LineType
||00406  | 1 2 3 4 5 6 7 1 1
||00407  |LineSize
||00408  | 0 1 2 3 10 15 15 0 0
||00409  |Spline
||00410  | 0 0 0 0 0 0 0 0 0 0
||00411  |
||00412  |
```

```
00371 |[Arrow Styles]
00372 |
00373 |ArrowColor
00374 | 1 1 1 1 1 1 1 1 1 1
00375 |ArrowType
00376 | 0 0 0 0 0 0 0 0 0 0
00377 |ArrowSize
00378 | 2 2 2 2 2 2 2 2 2 2
00379 |ArrowX1
00380 | 0 0 0 0 0 0 0 0 0 0
00381 |ArrowY1
00382 | 90 80 70 60 50 40 30 20 10 0
00383 |ArrowX2
00384 | 10 10 10 10 10 10 10 10 10 10
00385 |ArrowY2
00386 | 90 80 70 60 50 40 30 20 10 0
00387 |LineType
00388 | 1 1 1 1 1 1 1 1 1 1
00389 |LineSize
00390 | 0 0 0 0 0 0 0 0 0 0
00391 |
00392 |
00393 |[Note Styles]
00394 |
00395 |NoteColor
00396 | 1 1 1 1 1 1 1 1 1 1
00397 |NoteFont
00398 | 0 0 0 0 0 0 0 0 0 0
00399 |NoteRefPoint
00400 | 0 0 0 0 0 0 0 0 0 0
00401 |NoteX
00402 | 10 10 10 10 10 10 10 10 10 10
00403 |NoteY
00404 | 90 80 70 60 50 40 30 20 10 0
00405 |NoteWidth
00406 | 1 1 1 1 1 1 1 1 1 1
00407 |NoteHeight
00408 | 4 4 4 4 4 4 4 4 4 4
00409 |NoteSpace
00410 | 0 0 0 0 0 0 0 0 0 0
00411 |NoteDirection
00412 | 0 0 0 0 0 0 0 0 0 0
00413 |NoteStrings
00414 |
00415 |
00416 |
00417 |
00418 |
00419 |
00420 |
00421 |
00422 |
00423 |
00424 |
00425 |[Caption Styles]
00426 |
00427 |CaptionColor
00428 | 0 0 0 0 0 0 0 0 0 0
00429 |CaptionFont
00430 | 0 0 0 0 0 0 0 0 0 0
00431 |CaptionRefPoint
00432 | 0 0 0 0 0 0 0 0 0 0
00433 |CaptionX
00434 | 0 0 0 0 0 0 0 0 0 0
00435 |CaptionY
00436 | 150 145 140 135 130 125 120 115 110
00437 |CaptionWidth
00438 | 1 1 1 1 1 1 1 1 1
00439 |CaptionHeight
00440 | 4 4 4 4 4 4 4 4 4
00441 |CaptionSpace
00442 | 0 0 0 0 0 0 0 0 0
00443 |CaptionDirection
00444 | 0 0 0 0 0 0 0 0 0
00445 |CaptionStrings
00446 |
00447 |
00448 |
00449 |
00450 |
00451 |
00452 |
00453 |
00454 L|@1 DATA01.TXT   A main title of presented Graph
00455 |
00456 |[End of file]
```

```
||00413 |[Arrow Styles]
||00414 |
||00415 |ArrowColor
||00416 | 1 1 1 1 1 1 1 1 1 1
||00417 |ArrowType
||00418 | 0 0 0 0 0 0 0 0 0 0
||00419 |ArrowSize
||00420 | 2 2 2 2 2 2 2 2 2 2
||00421 |ArrowX1
||00422 | 0 0 0 0 0 0 0 0 0 0
||00423 |ArrowY1
||00424 | 90 80 70 60 50 40 30 20 10 0
||00425 |ArrowX2
||00426 | 10 10 10 10 10 10 10 10 10 10
||00427 |ArrowY2
||00428 | 90 80 70 60 50 40 30 20 10 0
||00429 |LineType
||00430 | 1 1 1 1 1 1 1 1 1 1
||00431 |LineSize
||00432 | 0 0 0 0 0 0 0 0 0 0
||00433 |
||00434 |
||00435 |[Note Styles]
||00436 |
||00437 |NoteColor
||00438 | 1 1 1 1 1 1 1 1 1 1
||00439 |NoteFont
||00440 | 0 0 0 0 0 0 0 0 0 0
||00441 |NoteRefPoint
||00442 | 0 0 0 0 0 0 0 0 0 0
||00443 |NoteX
||00444 | 10 10 10 10 10 10 10 10 10 10
||00445 |NoteY
||00446 | 90 80 70 60 50 40 30 20 10 0
||00447 |NoteWidth
||00448 | 1 1 1 1 1 1 1 1 1 1
||00449 |NoteHeight
||00450 | 4 4 4 4 4 4 4 4 4 4
||00451 |NoteSpace
||00452 | 0 0 0 0 0 0 0 0 0 0
||00453 |NoteDirection
||00454 | 0 0 0 0 0 0 0 0 0 0
||00455 |NoteStrings
||00456 |
||00457 |
||00458 |
||00459 |
||00460 |
||00461 |
||00462 |
||00463 |
||00464 |
||00465 |
||00466 |
||00467 |[Caption Styles]
||00468 |
||00469 |CaptionColor
||00470 | 0 0 0 0 0 0 0 0 0 0
||00471 |CaptionFont
||00472 | 0 0 0 0 0 0 0 0 0 0
||00473 |CaptionRefPoint
||00474 | 0 0 0 0 0 0 0 0 0 0
||00475 |CaptionX
||00476 | 0 0 0 0 0 0 0 0 0 0
||00477 |CaptionY
||00478 | 150 145 140 135 130 125 120 115 110
||00479 |CaptionWidth
||00480 | 1 1 1 1 1 1 1 1 1
||00481 |CaptionHeight
||00482 | 4 4 4 4 4 4 4 4 4
||00483 |CaptionSpace
||00484 | 0 0 0 0 0 0 0 0 0
||00485 |CaptionDirection
||00486 | 0 0 0 0 0 0 0 0 0
||00487 |CaptionStrings
||00488 |
||00489 |
||00490 |
||00491 |
||00492 |
||00493 |
||00494 |
||00495 |
||00496 R|
||00497 |
||00498 |[End of file]
```

Figure 9. In using df.exe tool extraction, schematic illustration of differences between Arrhen.GPR and INIT.GPR for executable parameters on graph plot tool GP.exe is shown. INIT.GPR is completely similar with the list in Figure 8. On the other hand, Arrhen.GPR has a data of data01.txt that has four groups of data as shown in Table 1 and four groups of linear line in Arrhenius relationship plotting on temperature inverse and legalism D value as shown in Figure 10

http://dx.doi.org/10.5772/60993

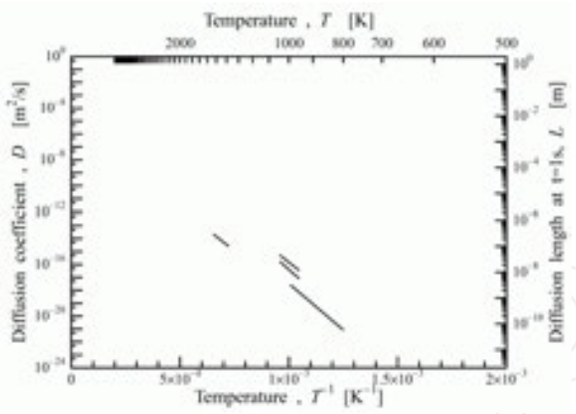


Figure 10. Schematic illustration plots, e.g., for 4 groups of linear line in Arrhenius relationship plotting on temperature inverse and legalism *D* value; in Table 1, there are four lines of Arrhenius plots, respectively

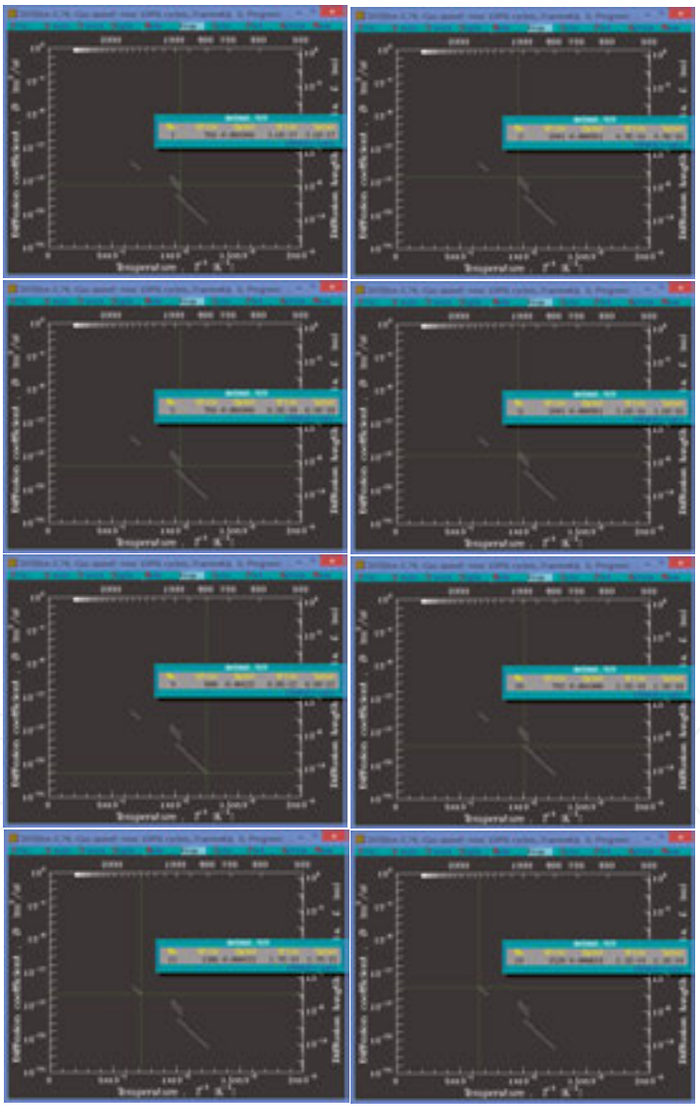


Figure 11. GP.exe schematic illustrations for searching the plots and their points, which, e.g., plots for four groups of linear line in Arrhenius relationship plotting on temperature inverse and legalism *D* value. There is, e.g., eight point edges of the right and left on the four linear lines

Figure 11. GP.exe schematic illustrations for searching the plots and their points, which, e.g., plots for four groups of linear line in Arrhenius relationship plotting on temperature inverse and legalism *D* value. There is, e.g., eight point edges of the right and left on the four linear lines

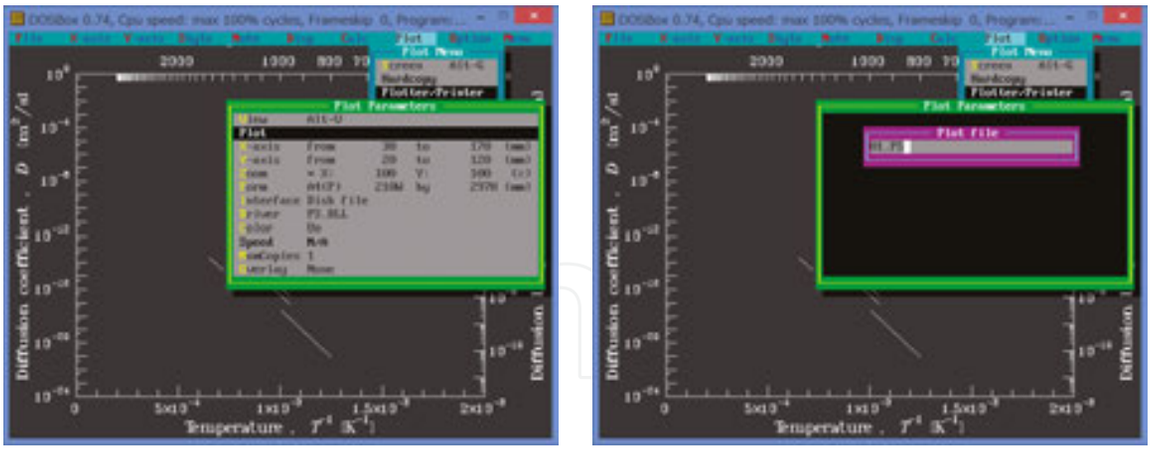


Figure 12 GP.exe schematic illustrations for creating the high-resolution PostScript picture as shown in Figure 11, which the file of 01.ps for common forms of Arrhenius plots using GP.exe. User can reproduce the similar frame Arrhenius plots using another diffusion data, to replace the data (filename from the data01.TXT to another filename, e.g. data02.TXT) into the *.GPR graph parameter file. Meanwhile, the user can transform precisely from 01.ps to 01gw.pdf (PDF: Portable Document Format) using freeware tool kit Ghostscript or gswin32c.exe with a textline command as follows: " C:/Program Files (x86)/gs/gs9.04/bin/gswin32c.exe" -dNOPAUSE -dBATCH -sDEVICE=pdfwrite -r600 -sOutputFile=01gw.pdf -c 300000 s

Figure 12. GP.exe schematic illustrations for creating the high-resolution PostScript picture as shown in Figure 11, which the file of 01.ps for common forms of Arrhenius plots using GP.exe. User can reproduce the similar frame Arrhenius plots using another diffusion data, to replace the data (filename from the data01.TXT to another filename, e.g., data02.TXT) into the *.GPR graph parameter file. Meanwhile, the user can transform precisely from 01.ps to 01gw.pdf (PDF: Portable Document Format) using freeware tool kit Ghostscript or gswin32c.exe with a textline command as follows: " C:/Program Files (x86)/gs/gs9.04/bin/gswin32c.exe" -dNOPAUSE -dBATCH -sDEVICE=pdfwrite -r600 -sOutputFile=01gw.pdf -c 300000 setvmthreshold save pop -f 01.ps "

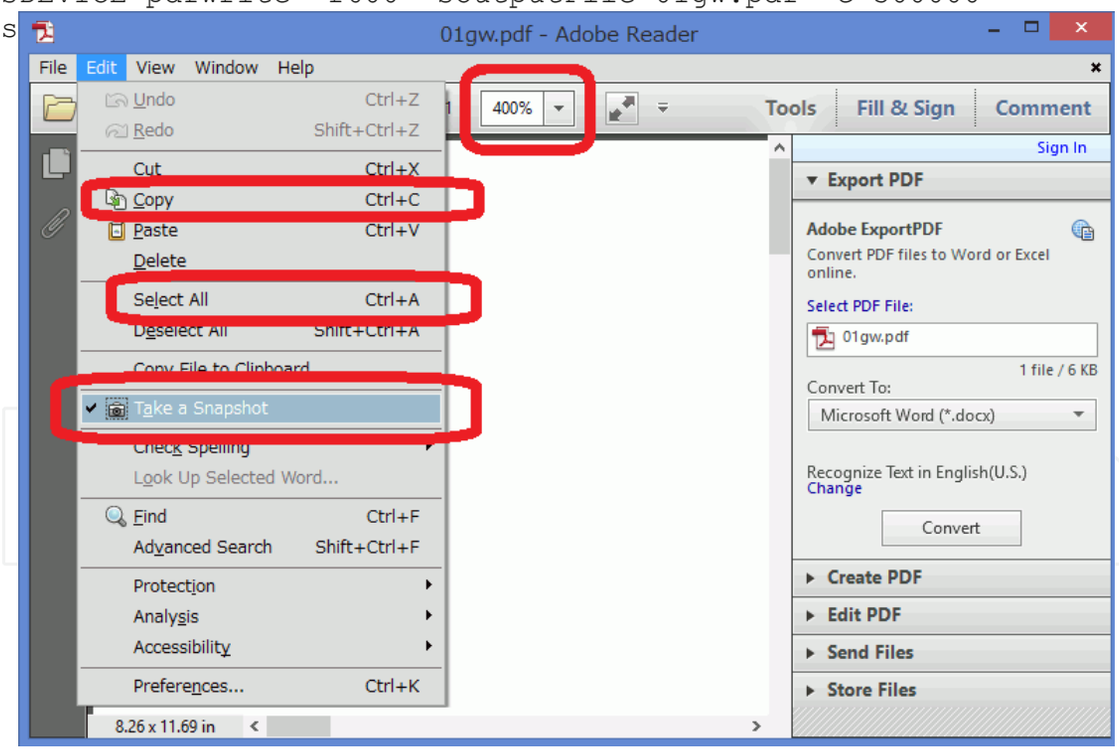


Figure 13 Adobe reader schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) picture as all pictures shown are presented in this paper. Using freeware of Adobe Reader or Adobe Acrobat Reader, the user opens the PDF of 01gw.pdf, sets the magnitude to "400 %," activates "Take a Snapshot," chooses "Select All," and finally chooses "Copy." All through the process, the user can copy the graphic data onto the Windows OS, Mac OS, and Linux OS clipboard

Figure 13. Adobe reader schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) picture as all pictures shown are presented in this paper. Using freeware of Adobe Reader or Adobe Acrobat Reader, the user opens the PDF of 01gw.pdf, sets the magnitude to "400 %," activates "Take a Snapshot," chooses "Select All," and finally chooses "Copy." All through the process, the user can copy the graphic data onto the Windows OS, Mac OS, and Linux OS clipboard

http://dx.doi.org/10.5772/60993

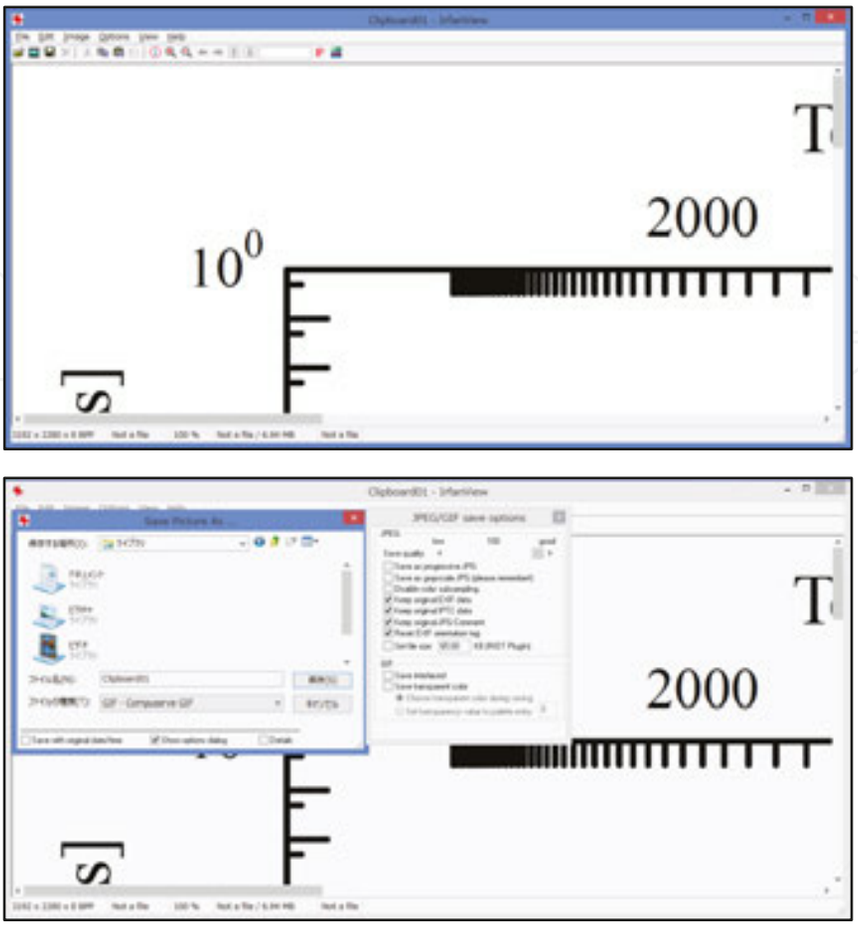


Figure 14. Image processing software schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) pictures as all pictures shown are presented in this paper. For example, using the freeware "IrfanView," the user opens the menu "Save Picture As" of clipboard picture data and pastes it by "Paste Ctrl+V," and the user can copy and paste through the graphic Windows OS clipboard. Finally, almost 94 kByte of compact-size and high-resolution GIF file was created via AWK, DOSBox, GP.exe, C.winsub.exe, Adobe Reader, and IrfanView. This high-resolution GIF file of around 94 kByte would be user friendly for making documentation with graphic pictures. The Other standard graphic file formats of JPEG, PNG, BMP, TIF, etc., are able to apply in a similar procedure with high-performance IrfanView

Figure 14. Image processing software schematic illustrations for creating the high-resolution GIF (Graphics Interchange Format) pictures as all pictures shown are presented in this paper. For example, using the freeware "IrfanView," the user opens the menu "Save Picture As" of clipboard picture data and pastes it by "Paste Ctrl+V," and the user can copy and paste through the graphic Windows OS clipboard. Finally, almost 94 kByte of compact-size and high-resolution GIF file was created via AWK, DOSBox, GP.exe, C.winsub.exe, Adobe Reader, and IrfanView. This high-resolution GIF file of around 94 kByte would be user friendly for making documentation with graphic pictures. The Other standard graphic file formats of JPEG, PNG, BMP, TIF, etc., are able to apply in a similar procedure with high-performance IrfanView

3. Technique for information processing

3.1. Command line technique for PDF from PS

How to create a worksite shortcut for the elevated command prompt in Windows 8 and 10:

1. Open search by typing Ctrl+S and enter "cmd" in the search box, as shown below on the upper left. 2. Right click the Command Prompt results and choose Open file location, as shown below on the upper right. 3. Copy the shortcut Command Prompt to the worksite, e.g., C:/prog/gp/worksite/. It is necessary for instructions to include the file and directory name within length of 8 and 3, because of the software of legacy-type DOS.

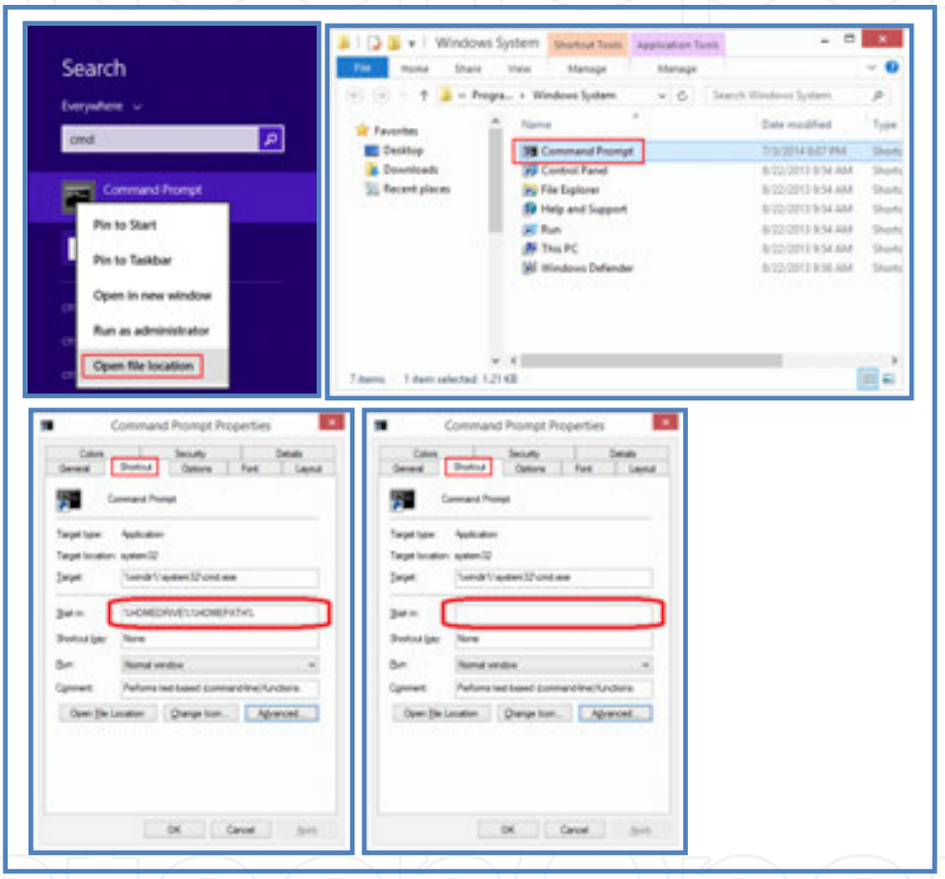
3.1 Command Line Technique for PDF from PS

¶(6pt)

As shown in Figure 15, how to create a worksite shortcut for the elevated command prompt in Windows 8 and 10:

1. Open search by typing Ctrl + S and enter "cmd" in the search box, as shown below on the upper left. 2. Right click the Command Prompt results and choose Open file location, as shown below on the upper right. 3. Copy the shortcut Command Prompt to the worksite, e.g., C:/prog/gp/worksite/. It is necessary for instructions to include the file and directory name within length of 8 and 3, because of the software of legacy-type DOS.

4. In the worksite, e.g., C:/prog/gp/worksite/, right click the shortcut Command Prompt to open the Command Prompt Property, as shown below on the lower left. 5. In the Command Prompt Property, delete the description in the "Start in," as shown below on the lower right. 6. In the worksite, e.g., C:/prog/gp/worksite/, execute the GP.exe and save a 01.PS in the worksite. 6. In the worksite, e.g., C:/prog/gp/worksite/, click the shortcut Command Prompt; then paste the textline from a described text file to the Command Prompt window, where the textline would be " C:/Program Files (x86)/ gs/gs9.04 /bin/ gswin32c.exe" -dNOPAUSE -dBATCH -sDEVICE=pdfwrite -r600 –sOutputFile=01gw.pdf -c 300000 setvmthreshold save pop -f 01.ps " (e.g., there was already a need for the environment of installed gswin32 toolkit).



c

Figure 15. Schematic illustrations of command line technique for PDF from PS

3.2. Method to narrow down the diffusion database

How to narrow down the overflowed results of diffusion database from the over-100 score:

1. Open Web-based diffusion coefficient database presented NIMS, National Institute for Materials Science, Japan.
2. Select "Advanced Search."
3. Select "Diffusant." And input in "Included matched form" as shown below (e.g., if Fe would be entered, the search result includes Fe, 57Fe, Fe57, Fe59, Fe55, etc.).

4. If the result score would be over-100 data, you should better narrow down the over-100 scored data using Q of activation energy.

5. If from 0 to blank would be entered, selected data would be only Arrhenius relations paired data without single temperature diffusion data, as shown below.

6. Input an integer both of the "form", normally: e.g., it should be from 0 to blank, from 0 to 100, from 101 to 200, from 251 to blank, etc.

3.3. Method to change the character strings into numbers at one dash

How to change the character strings of the spreadsheet into number lines at one dash:

1. Open a fresh spreadsheet that would be, e.g., MS Excel.

2. Open Web-based diffusion coefficient database presented NIMS, National Institute for Materials Science, Japan.

3. Use a method to narrow down the diffusion database. Then on the narrowed-down database "frameset" list, which would be selected all of "frameset" on it, and then "copy" to store into a clipboard data zone, then paste on to the spreadsheet from the clipboard.

4. Now at the area of a spreadsheet, e.g., MS Excel, character strings, e.g., D_0 2.00E-05, Q 264, T_{min} 1123, and T_{max} 1699, still should be the character strings in Figure 2.

5. At one dash, the area of spreadsheet character strings, e.g., 2.00E-05, 264, 1123, and 1699, are selected and "Copy" is selected to store into a clipboard data zone and then it is pasted on to the high-end text editor, e.g., terapad.exe (Japanese only), etc., from the clipboard.

6. On the high-end text editor, these character strings would be, e.g., 2.00E-05?, 264?, 1123?, and 1699?; then they should be changed into 2.00E-05, 264, 1123, and 1699 by using "displacement" function effect.

7. Finally, at one dash, they should be copied – all of the 2.00E-05, 264, 1123, and 1699 numbers – into a clipboard data zone and then pasted to override onto the similar area of a spreadsheet character strings.

3.2 Method to Narrow Down the Diffusion Database ¶(6pt)

How to narrow down the overflowed results of diffusion database from the over-100 score:

1. Open Web-based diffusion coefficient database presented NIMS, National Institute for Materials Science, Japan.
2. Select "Advanced Search."
3. Select "Diffusant." And input in "Included matched form" as shown below (e.g., if Fe would be entered, the search result includes Fe, 57Fe, Fe57, Fe59, Fe55, etc.).
4. If the result score would be over-100 data, you should better narrow down the over-100 scored data using Q of activation energy.
5. If from 0 to blank would be entered, selected data would be only Arrhenius relations paired data without single temperature diffusion data, as shown below.
6. Input an integer both of the "form", normally: e.g., it should be from 0 to blank, from 0 to 100, from 101 to 200, from 251 to blank, etc.

3.3 Method to Change the Character Strings into Numbers at One Dash ¶(6pt)

As shown in Figure 16, how to change the character strings of the spreadsheet into number lines at one dash:

1. Open a fresh spreadsheet that would be, e.g., MS Excel.
2. Open Web-based diffusion coefficient database presented NIMS, National Institute for Materials Science, Japan.
3. Use a method to narrow down the diffusion database. Then on the narrowed-down database "frameset" list, which would be selected all of "frameset" on it, and then "copy" to store into a clipboard data zone, then paste on to the spreadsheet from the clipboard.
4. Now at the area of a spreadsheet, e.g., MS Excel, character strings, e.g., D_0 2.00E-05, Q 264, T_{min} 1123, and T_{max} 1699, still should be the character strings in Figure 2.
5. At one dash, the area of spreadsheet character strings, e.g., 2.00E-05, 264, 1123, and 1699, are selected and "Copy" is selected to store into a clipboard data zone and then it is pasted on to the high-end text editor, e.g., terapad.exe (Japanese only), etc., from the clipboard.
6. On the high-end text editor, these character strings would be, e.g., 2.00E-05?, 264?, 1123?, and 1699?; then they should be changed into 2.00E-05, 264, 1123, and 1699 by using "displacement" function effect.
7. Finally, at one dash, they should be copied – all of the 2.00E-05, 264, 1123, and 1699 numbers – into a clipboard data zone and then pasted to override onto the similar area of a spreadsheet character strings.

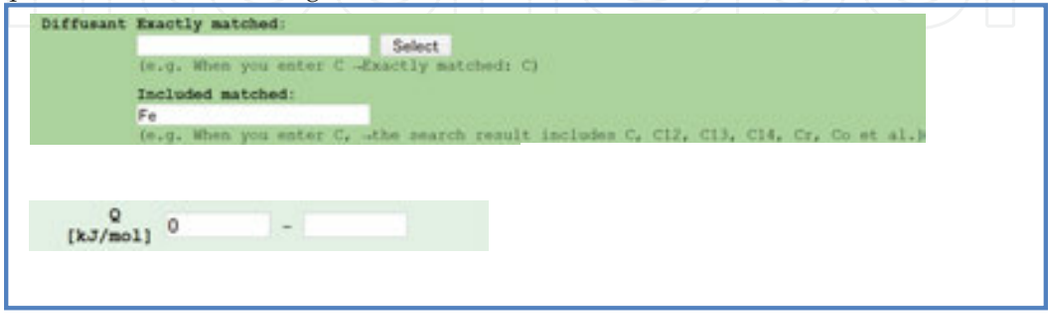


Figure 16. Schematic illustrations on how to narrow down the overflowed results of diffusion database from the over-100 score

4. Procedures and results of metallic systems

In the presented work by use of the AWK-GP-PDF, just suggested system procedure, the so-called big data via NIMS, National Institute for Materials Science, Japan, database was able to discuss it at once on one figure. First of all, in this research, Fe, Co, and Ni of metallic magnetic material were chosen and discussed through the system of AWK-GP-PDF.

4.1. Metallic magnetic material (Fe system)

In the metallic magnetic material of Fe system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 725 line data which has activation energy Q (kJ/mol) of 0 to 150 has 97 lines, Q of 151 to 200 has 99 lines, Q of 201 to 230 has 87 lines, Q of 231 to 250 has 82 lines, Q of 251 to 260 has 62 lines, Q of 261 to 275 has 68, Q of 276 to 285 has 82, Q of 286 to 300 has 68, and Q of 301 and over has 80 lines. In the presented search, diffusant included matches of Fe, 57Fe, Fe57, Fe59, and Fe55. Self-diffusion and other diffusion mechanism are mixture and bridged diffuse, but it would be observed mainstream in the figure. The so-called big data via NIMS, National Institute for Materials Science, Japan, database was able to discuss it at once on one figure. In this research, Fe, Co, and Ni of metallic magnetic material were chosen and discussed through the system of AWK-GP-PDF.

4.2. Metallic magnetic materials (Co system)

In the metallic magnetic material of Co system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 220 line data which has activation energy Q (kJ/mol) of 0 to 220 has 82 lines, Q of 221 to 300 has 98 lines, and Q of 301 and over has 80 lines. In the presented search, diffusant included matches of Co, Co60, and Co57. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 17, in the middle position of the graph.

4.3. Metallic magnetic materials (Ni system)

In the metallic magnetic material of Ni system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 582 line data which has activation energy Q (kJ/mol) of 0 to 120 has 67 lines, Q of 121 to 180 has 93 lines, Q of 181 to 220 has 78 lines, Q of 221 to 260 has 99 lines, Q of 261 to 280 has 75 lines, Q of 281 to 295 has 90 lines, and Q of 296 and over has 80 lines. In the presented search, diffusant included matches of Ni, Ni63, Ni66, and Ni59. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 17, in the lower position of the graph.

4.4. Metallic magnetic materials

In Figure 17, there are shown Arrhenius relationships with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Fe, Co, and Ni materials, respectively. Plots for

complex phenomena are shown; T of infinity D_0 should be D_0(Fe) > D_0 (Co) > D_0 (Ni), for it seems like it would be a relation of their atomic radii. Additionally, it seems like activation energies of Co are smaller than those of Ni as shown in Figure 17.

4.5. Cu, Zn, Al, Ga, Cr, and Mn systems

Cu, Zn, Al, Ga, Cr, and Mn systems of metal and alloy are useful and attractive materials in several industrial-purpose products; so in the following sections, the Arrhenius plots of self-diffusions and other diffusion mechanisms have been exemplified.

4.5.1. Cu system

In the metallic Cu system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 153 line data which has activation energy Q (kJ/mol) of 0 to 200 has 94 lines and Q of 201 and over has 59 lines. In the presented search, diffusant included matches of Cu, Cu64, and Cu67. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 18, in the upper graph.

4.5.2. Zn system

In the metallic Zn system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 175 line data which has activation energy Q (kJ/mol) of 0 to 120 has 80 lines, Q of 121 to 200 has 72 lines, and Q of 251 and over has 23 lines. In the presented search, diffusant included matches of Zn, Zn65, Zn95, and Zn69. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 18, in the lower position of the graph.

4.5.3. Summary of the metallic Cu or Zn system

In Figure 18, Arrhenius relationships with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cu and Zn materials, respectively, are shown. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cu) > D_0(Zn), for it seems like it would be a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should be D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Moreover, it seems that Q of activation energies Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn).

4.5.4. Al system

In the metallic Al system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 111 line data which has activation energy Q (kJ/mol) of 0 to 300 has 80 lines and Q of 301 and over has 31 lines. In the presented search, diffusant included matches of Al, Al26, and Al27. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 19, in the upper part of graph.

4.5.5. Ga system

In the metallic Ga system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 63 line data which has activation energy Q (kJ/mol) of 0 and over has 63 lines. In the presented search, diffusant included matches of Ga, Ga67, Ga72, Ga69, and Ga71. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 19, at the lower position of the graph.

4.5.6. Summary of the metallic Al or Ga system

In Figure 19, Arrhenius relationships with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Al and Ga of the similar 3 valence bonding numbers, respectively, are shown. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Al) > D_0(Ga), for it seems like it would be a relation of their atomic radii.

Additionally, in relation with Figures 17 and 18, D_0 should almost be D_0(Al) > D_0(Ga) > D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Moreover, it seems like it would be that Q of activation energies is Q(Al) > Q(Ga) > Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn).

4.5.7. Cr system

In the metallic Cr system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 205 line data which has activation energy Q (kJ/mol) of 0 to 230 has 79 lines, Q of 231 to 300 has 90 lines, and Q of 300 and over has 36 lines. In the presented search, diffusant included matches of Cr, Cr51, and Cr48. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 20, in the upper part of the graph.

4.5.8. Mn system

In the metallic Mn system, in the presented work by use of the AWK-GP-PDF system procedure, Arrhenius plot of 111 line data which has activation energy Q (kJ/mol) of 0 to 250 has 83 lines and Q of 251 and over has 28 lines. In the presented search, diffusant included matches of Mn, Mn54, and Mn55. Self-diffusion and other diffusion mechanisms are mixture and bridged diffuse, but it would be observed mainstream in Figure 20, at the lower position of the graph.

4.5.9. Summary of the metallic Cr and Mn system

In Figure 20, Arrhenius relationships with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cr and Mn materials, respectively, are shown. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cr) > D_0(Mn), for it seems like it would be a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should almost be

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D_0(Cr) = D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Mn). Also it seems like it would be that Q of activation energies is Q(Cr) = Q(Fe) > Q(Co) > Q(Ni) > Q(Mn).

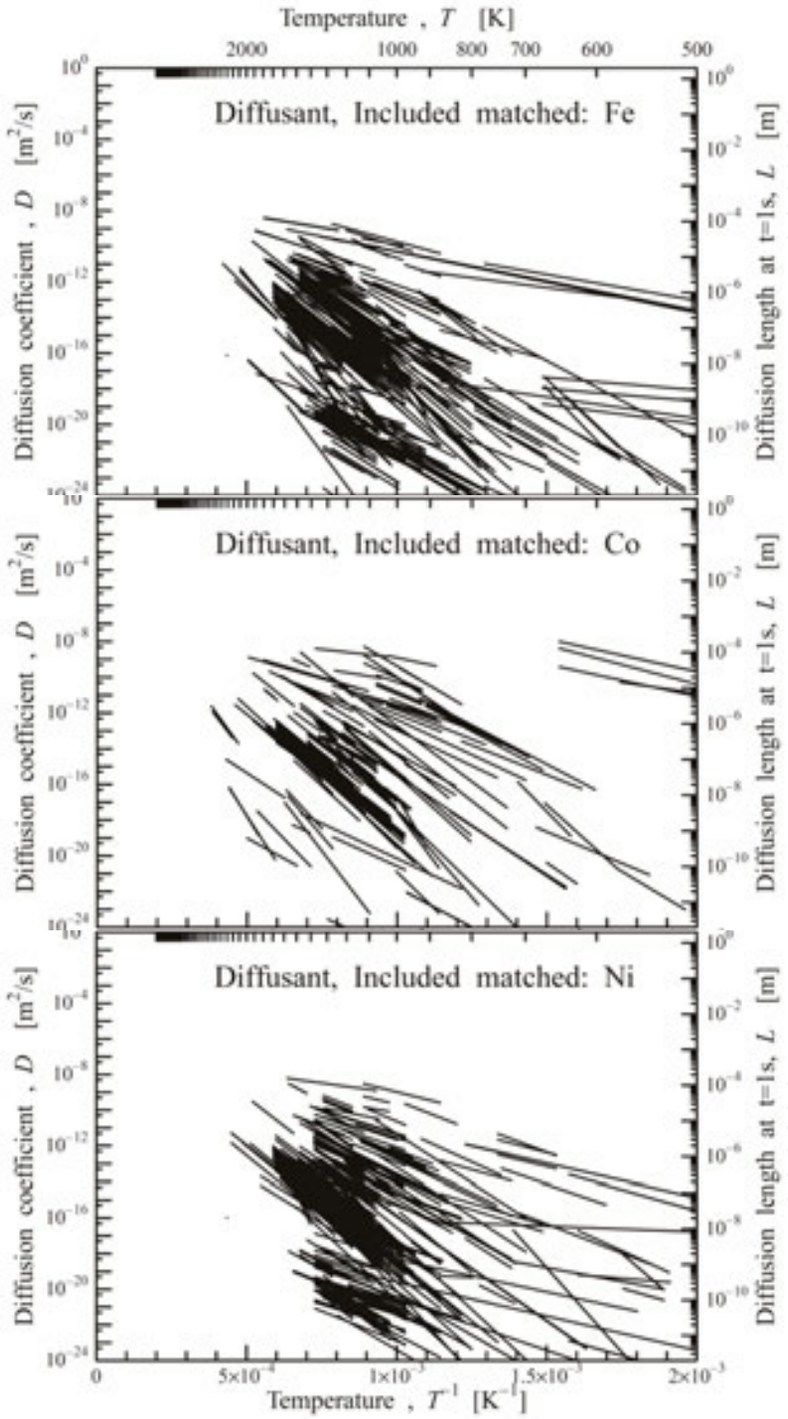

Figure 17. Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Fe, Co, and Ni materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Fe) > D_0(Co) > D_0(Ni), for a relation of their atomic radii

Figure 17 Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Fe, Co, and Ni materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Fe) > D_0(Co) > D_0(Ni), for a relation of their atomic radii

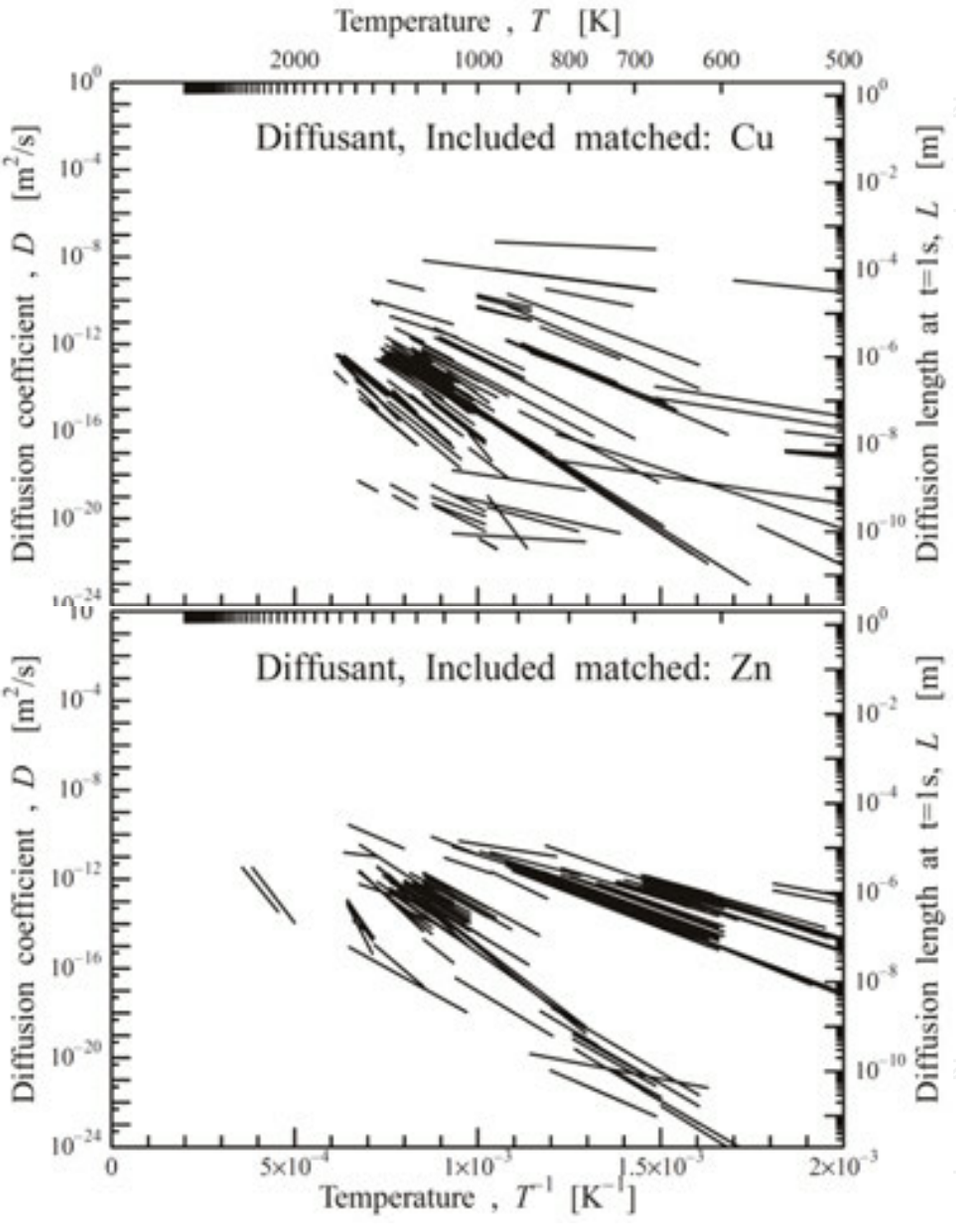

Figure 18 Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cu and Zn materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cu) > D_0(Zn), for a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should be D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Also it looks like Q of activation energy is Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn)

Figure 18. Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cu and Zn materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cu) > D_0(Zn), for a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should be D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Also it looks like Q of activation energy is Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn)

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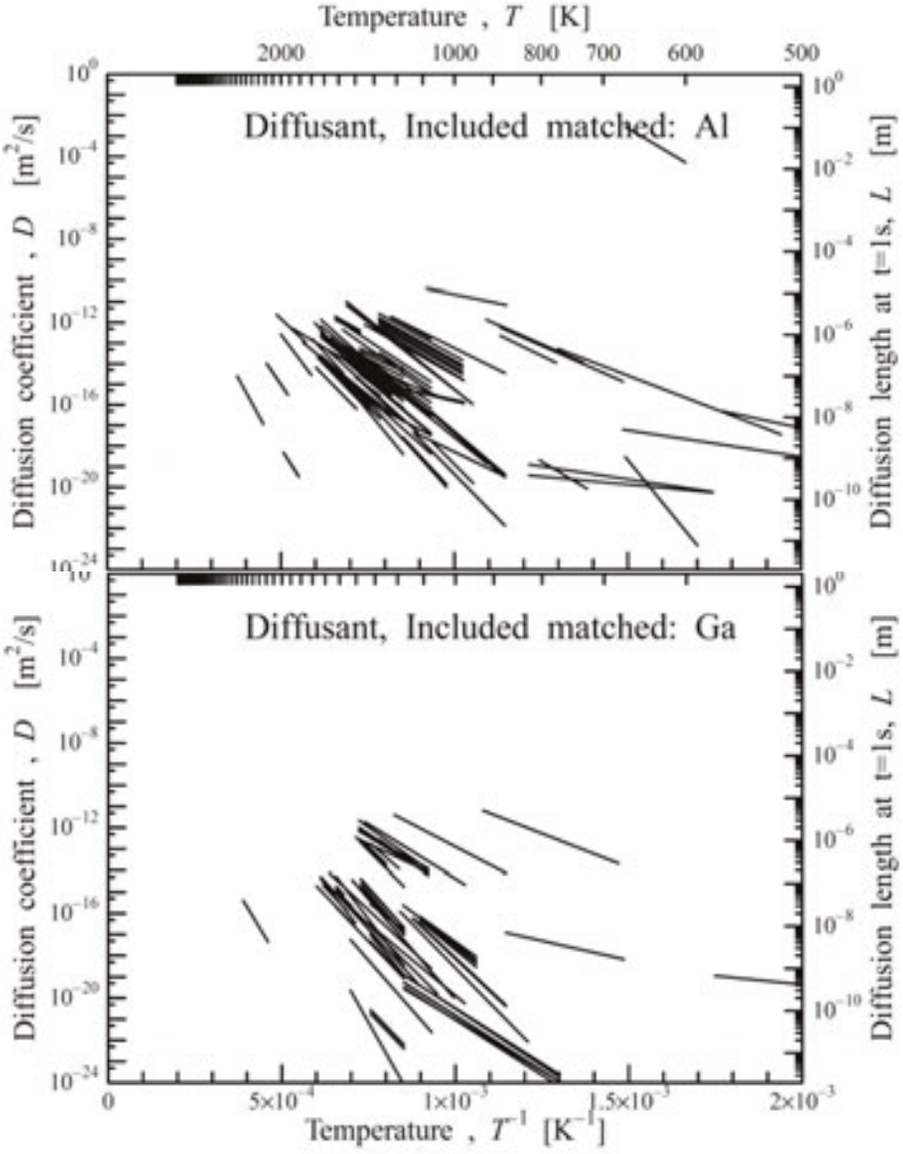

Figure 19 Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Al and Ga of the similar 3 valence bonding numbers, respectively. Plots for complex phenomena are shown: T of infinity D_0 should be D_0(Al) > D_0(Ga), for a relation of their atomic radii. Additionally, in relation with Figures 17 and 18, D_0 should almost be D_0(Al) > D_0(Ga) > D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Also it looks like Q of activation energy is Q(Al) > Q(Ga) > Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn)

Figure 19. Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Al and Ga of the similar 3 valence bonding numbers, respectively. Plots for complex phenomena are shown: T of infinity D_0 should be D_0(Al) > D_0(Ga), for a relation of their atomic radii. Additionally, in relation with Figures 17 and 18, D_0 should almost be D_0(Al) > D_0(Ga) > D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Cu) > D_0(Zn). Also it looks like Q of activation energy is Q(Al) > Q(Ga) > Q(Fe) > Q(Co) > Q(Ni) > Q(Cu) > Q(Zn)

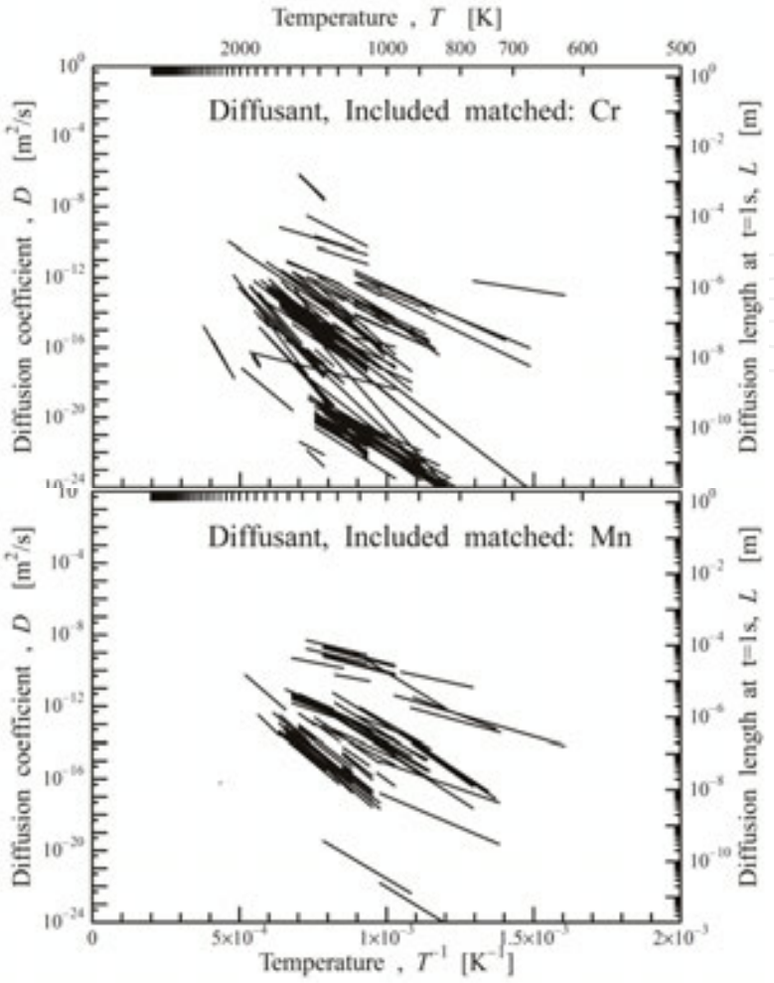

Figure 20. Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cr and Mn materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cr) > D_0(Mn), for a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should almost be D_0(Cr) = D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Mn). Also it looks like Q of activation energy is Q(Cr) = Q(Fe) > Q(Co) > Q(Ni) > Q(Mn)

Figure 20. Arrhenius relationship with horizontal axis of temperature T inverse and vertical axis of logalism diffusion coefficient D via self-diffusion and other diffusion mixed mechanisms with diffusant Cr and Mn materials, respectively. Plots for complex phenomena are shown; T of infinity D_0 should be D_0(Cr) > D_0(Mn), for a relation of their atomic radii. Additionally, in relation with Figure 17, D_0 should almost be D_0(Cr) = D_0(Fe) > D_0(Co) > D_0(Ni) > D_0(Mn). Also it looks like Q of activation energy is Q(Cr) = Q(Fe) > Q(Co) > Q(Ni) > Q(Mn)

5. Conclusion

In Fe, Co, Ni, Cu, Zn, Al, Ga, Cr, and Mn alloys, considerable work has been done to obtain reliable value of diffusion coefficient, particularly because of the importance of physical constant values in specified materials. Meanwhile, free-of-charge Web-based diffusion coefficient database presents NIMS with over 8,000 diffusion data. It has been successfully provided.

In the present work, firstly, instructions to narrow down the diffusion database, to calculate using a specific spreadsheet for minimum temperature T_{min} vs diffusion coefficient $D(T_{min})$ and maximum temperature T_{max} vs diffusion coefficient $D(T_{max})$, to reform text file format using

AWK language, and to use computer drawing programs GP.exe to make an Arrhenius plot picture have been constructed through the process of Web-connected and numerical-based technique. Addition secondary to plot 9 kinds of Arrhenius relations Fe, Co, Ni, Cu, Zn, Al, Ga, Cr, and Mn to be comparison among the relations has been drawing.

Mainly, the tendency of the plots for complex phenomena, T of infinity D_0, regarding the relation of their atomic radii has been shown. Meanwhile, also the tendency Q of activation energy was discussed.

It was the tutorial on high-resolution PDF builder using the freeware in GP.EXE that was designed until 1999 to make smart graphs for publication with powerful data analysis ability such as Arrhenius relations T inverse and legalism plot. And now it is shown that the GP.EXE has been useful for genuine data processing even in 2015.

Finally, it is concluded that graph plot tool GP.exe and its extracted high-resolution PostScript and PDF with common forms of optimized Arrhenius plots using Arrhen.GPR showed good performance, because it produced a similar frame with the Arrhenius plots using diffusion data to replace into the GPR graph parameter file.

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