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Reactor Technologies**

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**THERPRO
The IAEA Database for Thermophysical Properties of Materials in Nuclear Reactors**

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THERPRO: The IAEA Database for Thermophysical Properties of Materials in Nuclear Reactors

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1. Background of THERPRO Database Development

- Assurance of accurate materials properties data has become an essential and an important part of all disciplines in science and engineering.
- In the nuclear engineering and industry, fundamental understanding of thermo-physical properties of the materials is crucial for the safety and performance of the current fleet of NPPs and for the development of advanced reactor designs. Thus, along with the necessary data measurements, continuous collection and systematic review/assessment of available data is being urgently demanded.
- IAEA kicked off the first CRP (Coordinated Research Project) on ‘Establishment of Thermo-physical Properties Data Base for LWRs and HWRs’ in late 90’s and since then two more CRPs have been organized by IAEA during the last ten years.
- Migration of DOS-based THERSYST DB to web-based data base was carried out during second CRP by ANM Lab. (Advanced Nuclear Materials Lab.) at Hanyang university in Korea and then renamed ‘THERPRO’ DB.
- At the end of third CRP Agency designated the ANM Lab as the center for THERPRO data base management with the financial support of Korean government. The CNMD (Center for Nuclear materials Database) at Hanyang university currently collects recent data, reviews and assesses the data, and formats them for entry into THERPRO DB.



1. Background of THERPRO Database Development (cont)

□ THERSYST DB: Inactive DOS-based Data Base:

- Developed by IKE (Institut für Kernenergie und Energiesysteme), Germany
- Developed as a combination of a factual database for thermo-physical properties of solids and a modular program for reactor calculation program RSYST to handle the database contents.
- Designed for mainframe computer (VAX) due to the sensitivity and the complexity of the properties database and later transformed to a stand-alone PC-based database since personal computers became popular and common.
- However, since its operating system was DOS and not upgraded properly, THERSYST DB failed to catch up the contemporary IT development and to meet the users' demand. Thus, it remained inactive and unserviceable even in early 90's.

□ THERPRO Database: Web-based On-line Data Base

- Web-based relational database completely re-designed and re-constructed while keeping the standard data format used in THERSYST DB.
 - Operating system : Red Hat Linux release 7.2
 - Data base management system : MySQL 3.23.41-1.



2. THERPRO Database: A Web-based Relational DB

- A web-based relational database currently available at
 - therpro.iaea.org
- It combines thermo-physical properties database and relational network DB management system using modern information technologies. THERPRO DB currently keeps more than 13,000 thermo-physical properties data tables of more than 1,300 materials.
- THERPRO shows thermo-physical property data **as a function of temperature** graphically and numerically.
 - **Three data retrieving ways**: Basic, Index, Power search
 - **Multiple choices** of data for comparison
 - **Each data includes** complete information including **source of the data**
- It offers a user-friendly environment for easy data retrieve.
 - GUI (Graphic User Interface) is utilized.
 - Pop-up screen menu and screen buttons are provided to make data selection and plot of the selected data very easy, removing the necessity of memorization of many descriptors.



2. THERPRO Database: A Web-based Relational DB (cont)

□ Properties Collected in THERPRO

The following properties data are collected and stored in THERPRO, **as a function of temperature**

Thermal Properties	Enthalpy Specific heat capacity Linear thermal expansion Volumetric thermal expansion
Transport Properties	Thermal conductivity Thermal diffusivity Electrical resistivity
Physical Properties	Density Lorenz number
Optical Properties	Emissivity Absorptivity Reflectivity Transmittance

3. OVERVIEW OF THERPRO

□ Standard Data Format in THERPRO

Thermal Conductivity of UO₂

Material Characterization
=====

material name: uranium dioxide
chemical formula: UO₂

chemical composition [mole(s)]:
UO₂ 1.0000
O/U ratio 2.0040 oxygen/metal ratio

physical state: solid

molecular mass: 270.0 g

Data Characterization
=====

accuracy: 5.0 %
classification: original measuring points

Measurement Technique
=====

property meas. method: longitudinal heat flow, absolute
temperature " : thermocouple
sample dimensions : disc, dia:6mm, l:1mm

measuring procedure: run B2

3. OVERVIEW OF THERPRO (cont)

Bibliography

=====

author: Schmidt H.E., Richter J., van den Berg M.
institution: Europaeisches Institut fuer Transurane,
Karlsruhe, FRG
title: Eine neue Methode zur Messung der
Waermeleitfaehigkeit.
source: BMBW-FB K 70-01(1970), 176-200
year of publ.: 1970
language: de

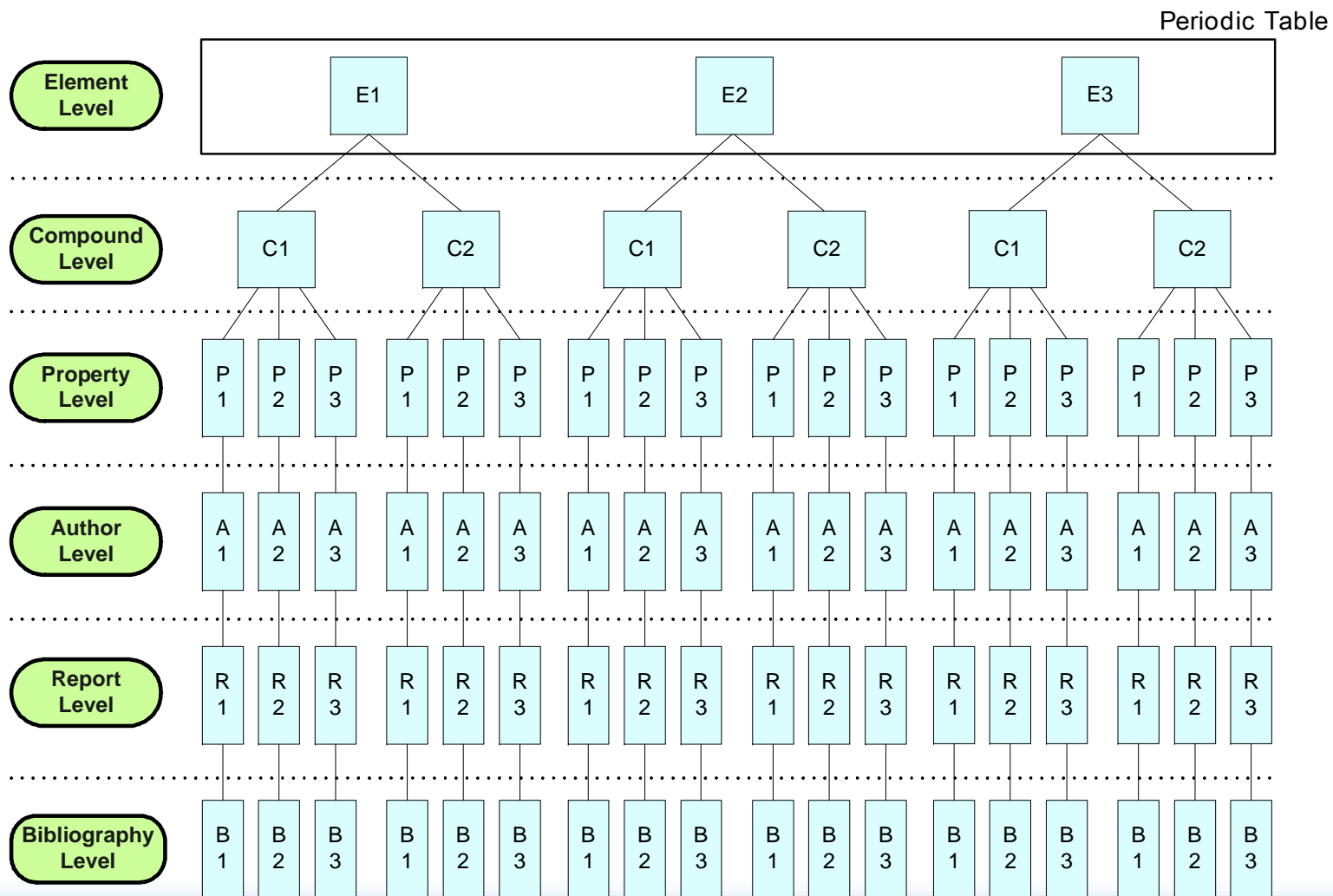
3.1515E+02 6.3000E-02
3.3615E+02 6.6000E-02
3.9415E+02 6.7400E-02
3.9415E+02 6.9100E-02
5.1415E+02 5.5500E-02
5.1415E+02 5.5500E-02
5.9815E+02 4.2500E-02
6.0815E+02 4.3700E-02
6.5915E+02 4.8900E-02
6.5915E+02 4.6400E-02
7.4815E+02 4.2200E-02
8.6615E+02 3.6500E-02

- This format is always kept as a standard and, once data or literature is collected, all the relevant information is converted into this form in order to avoid input difficulties and to keep the data base consistency.
- This bibliographical information on each data set is stored and linked to the data set file.



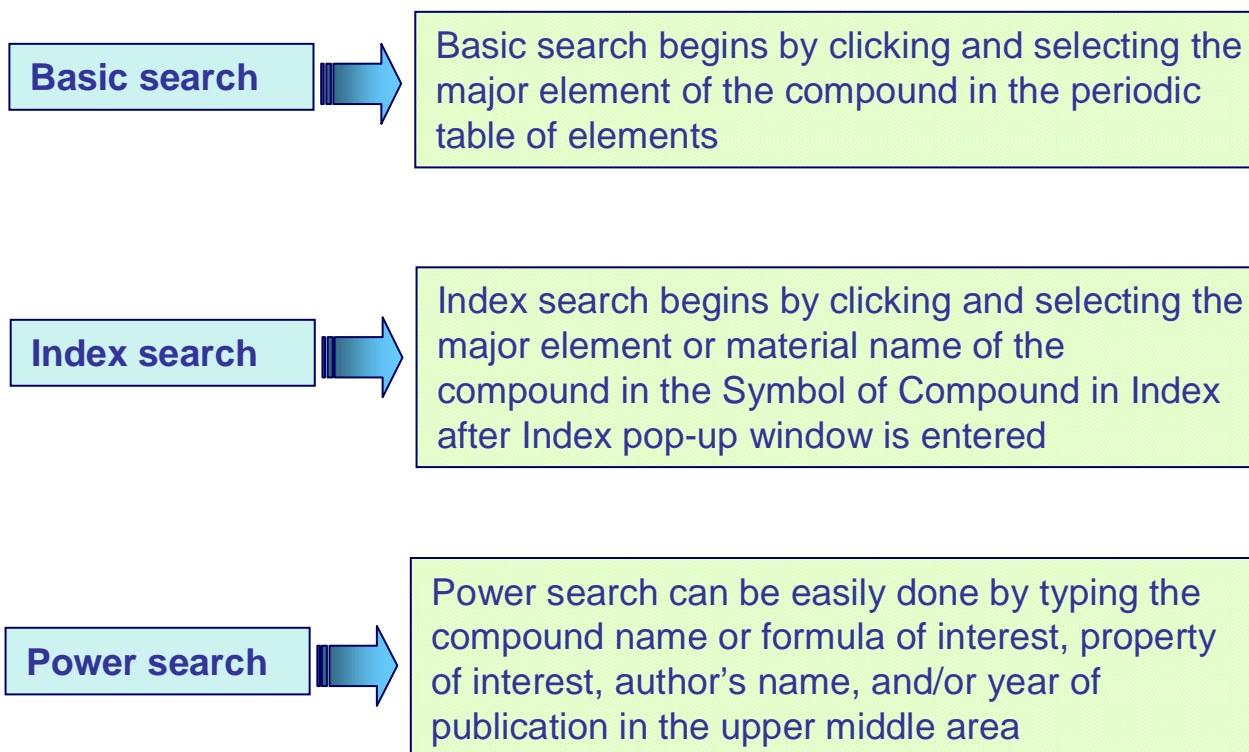
3. OVERVIEW OF THERPRO (cont)

□ Structure of THERPRO DB



3. OVERVIEW OF THERPRO: DATA RETRIEVAL

□ Three distinct access for data retrieve



3. OVERVIEW OF THERPRO: DATA RETRIEVAL (cont)

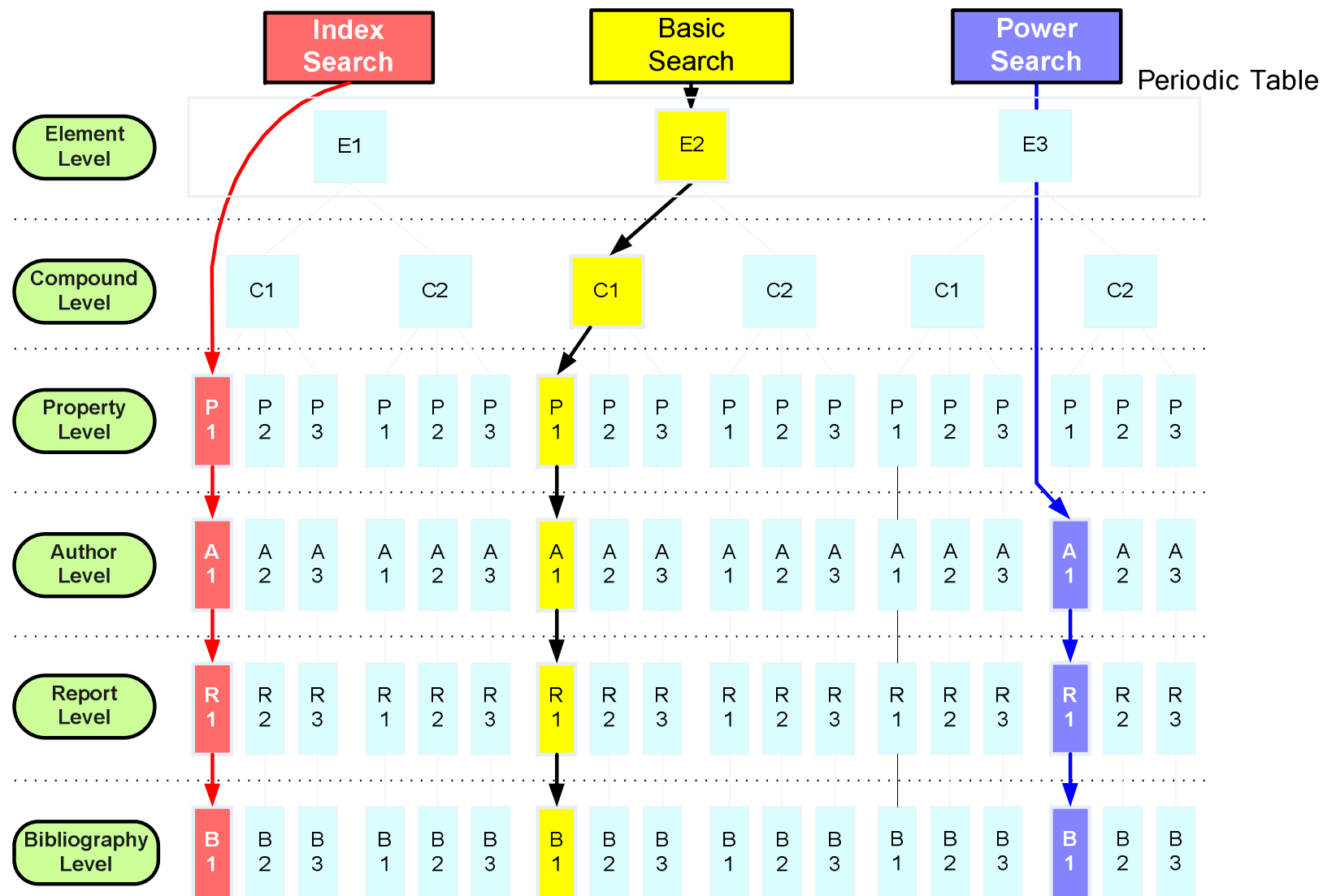


Fig 2. Data retrieve of THERPRO



3. OVERVIEW OF THERPRO: DATA RETRIEVAL (cont)

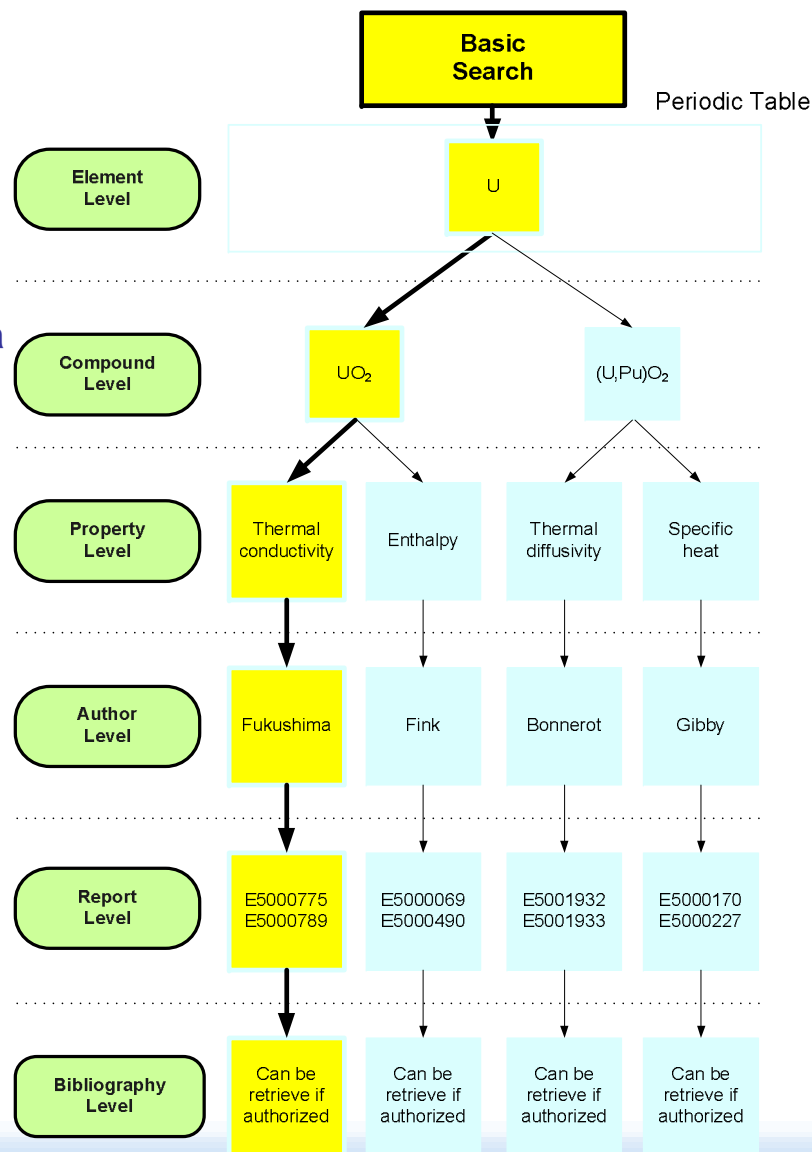
Basic search

Basic Table search that made hierarchical structure begins by clicking and selecting the major element of the compound in the periodic table of elements.

You can search thermo-physical materials data of THERPRO easily using GUI, Pop-up window menu and screen button.

Ex: Author's (B.C. AAA) work on thermal conductivity of UO_2

- 1) Click "U" in Element level
- 2) Select and click " UO_2 " in Compound level
- 3) Select and click "Thermal conductivity" in Property level
- 4) Select "Author" in Author level
- 5) Select "E5000775" in Report number listed in Report level
- 6) You can be retrieve if authorized about Bibliography data in Bibliography level



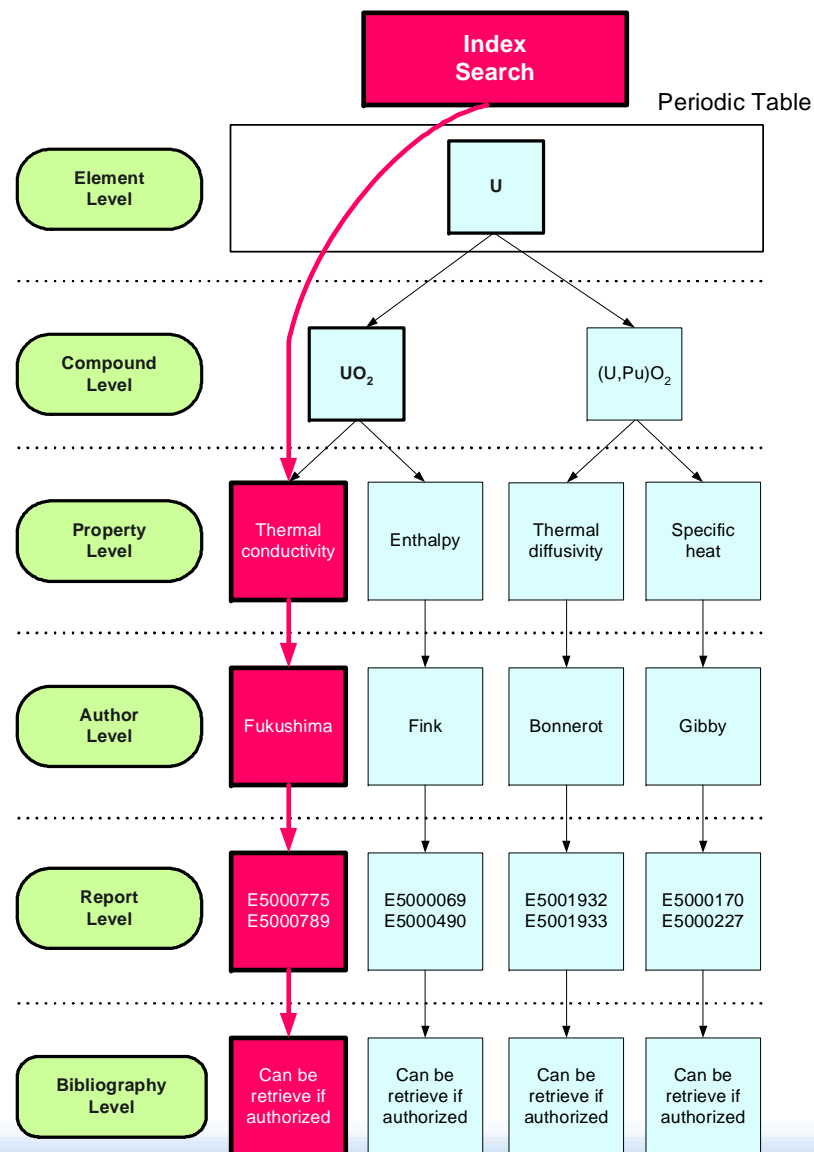
3. OVERVIEW OF THERPRO: DATA RETRIEVAL (cont)

Index search

Index search begins by clicking and selecting the major element or material name of the compound in the Symbol of Compound in Index after Index pop-up window is entered. You can see the element and compound list contained in THERPRO DB and you can search the data of THERPRO DB easily using this retrieve if you know material name and chemical formula.

Ex: Author's (B.C. AAA) work on thermal conductivity of UO_2

- 1) Type " UO_2 " and select "thermal conductivity, Author"
- 2) Select "Author" in Author level
- 3) Select "E5000775" in Report number listed in Report level
- 4) You can be retrieve if authorized about Bibliography data in Bibliography level



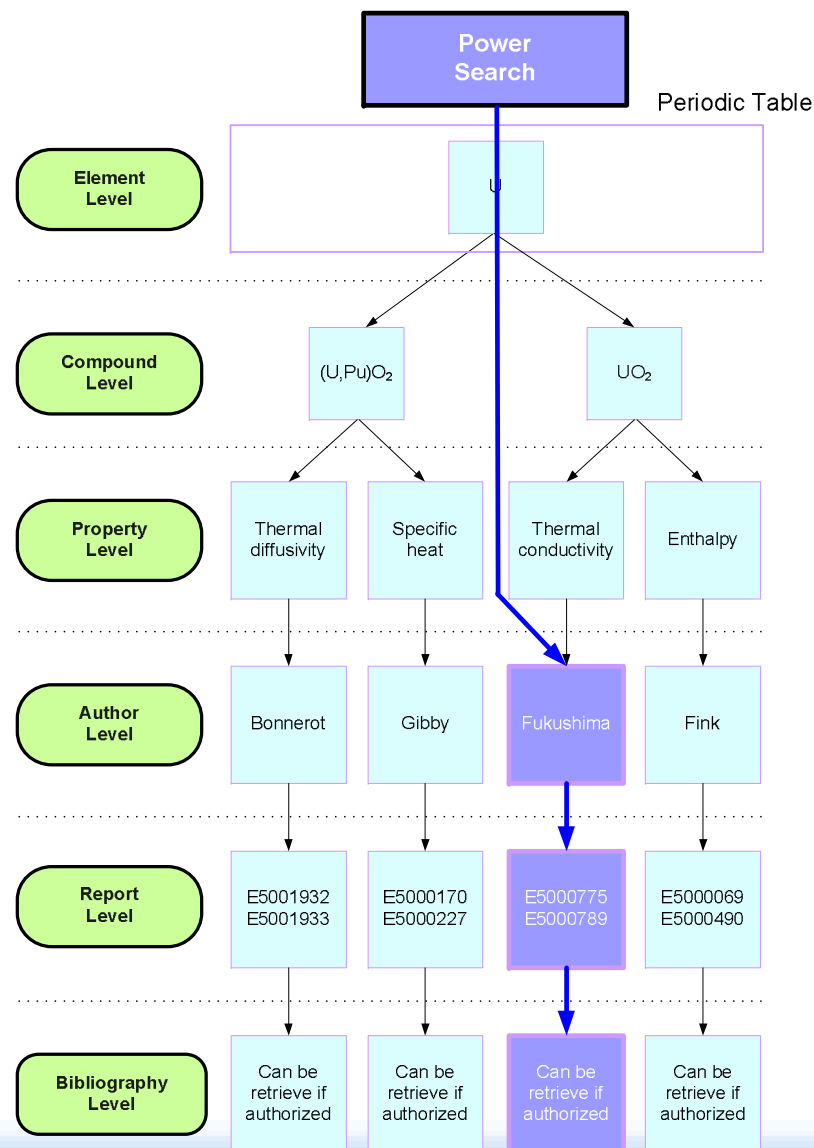
3. OVERVIEW OF THERPRO: DATA RETRIEVAL (cont)

Power search

Power search can be easily done by typing the compound name or formula of interest, property of interest, author's name, and/or year of publication in the upper middle area. You can search data of THERPRO conveniently if you know author's name by using this retrieve.

Ex: Author's (B.C. AAA) work on thermal conductivity of UO_2

- 1) Click "Index" and select " UO_2 "
- 2) Select "Author" in Author level
- 3) Select and click "Thermal conductivity" in Property level
- 4) Select "Author" in Author level
- 5) Select "E5000775" in Report number listed in Report level
- 6) You can be retrieve if authorized about Bibliography data in Bibliography level



DEMONSTRATION

Basic search

Index search

Power search

1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2)

The screenshot shows the IAEA THERPRO website interface. At the top, there is a navigation bar with links for Home, Search, Index, Link, BBS, DB Library, Help, and Contact Us. Below this is a search bar with a 'Live Search' button. The main content area features a periodic table of elements. The element Uranium (U) is highlighted with a red box, and a red arrow points to it from a text box that says 'Click Here (Periodic Table retrieve)'. Above the periodic table, there is a search interface with a 'Compound' input field, a 'Property' dropdown menu (set to '-- Select Property --'), and 'Search' and 'Power Search' buttons. The periodic table includes element symbols, atomic numbers, and names. The Lanthanides and Actinides series are shown below the main table. The Actinides series includes Uranium (U) with atomic number 92.

Fig 3. Homepage of THERPRO (Element level for Periodic Table retrieve)



1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO₂) cont.

IAEA THERPRO - Thermo-Physical Materials Properties Database

http://therpro.hanyang.ac.kr/

IAEA THERPRO - Thermo-Physical Mater...

IAEA THERPRO
Thermo-Physical Materials Properties Database

Manager | My Info | Logout | Admin | Level: Administrator

Resources for: Home | Search | Material: Uranium

U Uranium

92/238.029

Naturally occurring isotopes: 238 235 234
 Density: 19.04 (298.15K) g/cm³
 Melting point: 1132.3 ± 0.8 °C
 Boiling point: 3918 °C
 Latent heat of fusion: 65.08 J/g
 Specific heat: 0.1162 J/gK (at room temp.)
 Coefficient of lineal thermal expansion: 1.34E-05 cm/cmK (at room temp.)
 Thermal conductivity: 2.75E-01 W/cmK (at room temp.)
 Electrical resistivity: 2.70E-05 ohm-cm (at room temp.)
 Ionization potential (1st): 6.05 eV
 Electronic work function Φ: 3.63
 Oxidation potentials: U - U³⁺ + 3e = 1.789 V
 Chemical valence: 3 4 5 6
 Electrochemical equivalents: 1.4801 g/amp-hr
 Ionic radius: 0.52 (U⁶⁺) angstrom
 Valence electron potential (-eV): 170
 Principal quantum number: 7
 Principal electron shells:
 Electronic configuration: 1s2 2s2 2p6 3s2 3p6 3d10 4s2 4p6 4d10 4f14 5s2 5p6 5d10 5f3 6s2 6p6 6d1 7s2
 Valence electrons: 5f3 6d1 7s2
 Crystal form: Orthorhombic
 Half life: 4.51E9 years
 Cross section σ: 7.595 ± 0.070 barns
 Vapor pressure: 1.19E-06 Pa (at melting point)

Compound List

- (Pu,U)C (1)
- (Th,U)O2 (33)
- (Th,U)S (3)
- (U,Am)O2 (6)
- (U,Am,Np)O2 (2)
- (U,Am,Np)O3 (1)
- (U,Ce)C (5)
- (U,Eu)O2 (12)
- (U,Gd)O2 (22)
- (U,Nd)O2 (12)
- (U,Np)O2 (7)
- (U,Pu)C (45)
- (U,Pu)N (9)
- (U,Pu)O2 (316)
- (U,Pu)O2,Mo (5)
- (U,Pu,Ce)C (5)
- (U,Pu,Eu)O2 (8)
- (U,Pu,Mo)C (10)
- (U,Pu,Nd)O2 (4)
- (U,Pu,Ti)C (5)
- (U,Pu,Ti)O2 (1)
- (U,Pu,Zr)C (11)
- (U,Sm)O2 (12)
- (U,Th)O2 (10)
- (U,Th)S (8)
- (U,Th)Se (4)
- (U,Ti)O2 (1)
- (U,Y)O2 (12)
- (U,Zr)C (1)
- 235U (5)
- 238U (4)
- 239U (1)
- Al,U (8)
- Al3U (2)
- Be13U (2)
- Fe,U,Cr,X (2)
- Na3UO4 (7)
- Nb,U (6)
- Th,U (1)
- U (151)

Drag Here (Periodic Table retrieve)

Fig 4. Compound level for Periodic Table retrieve for UO₂



1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

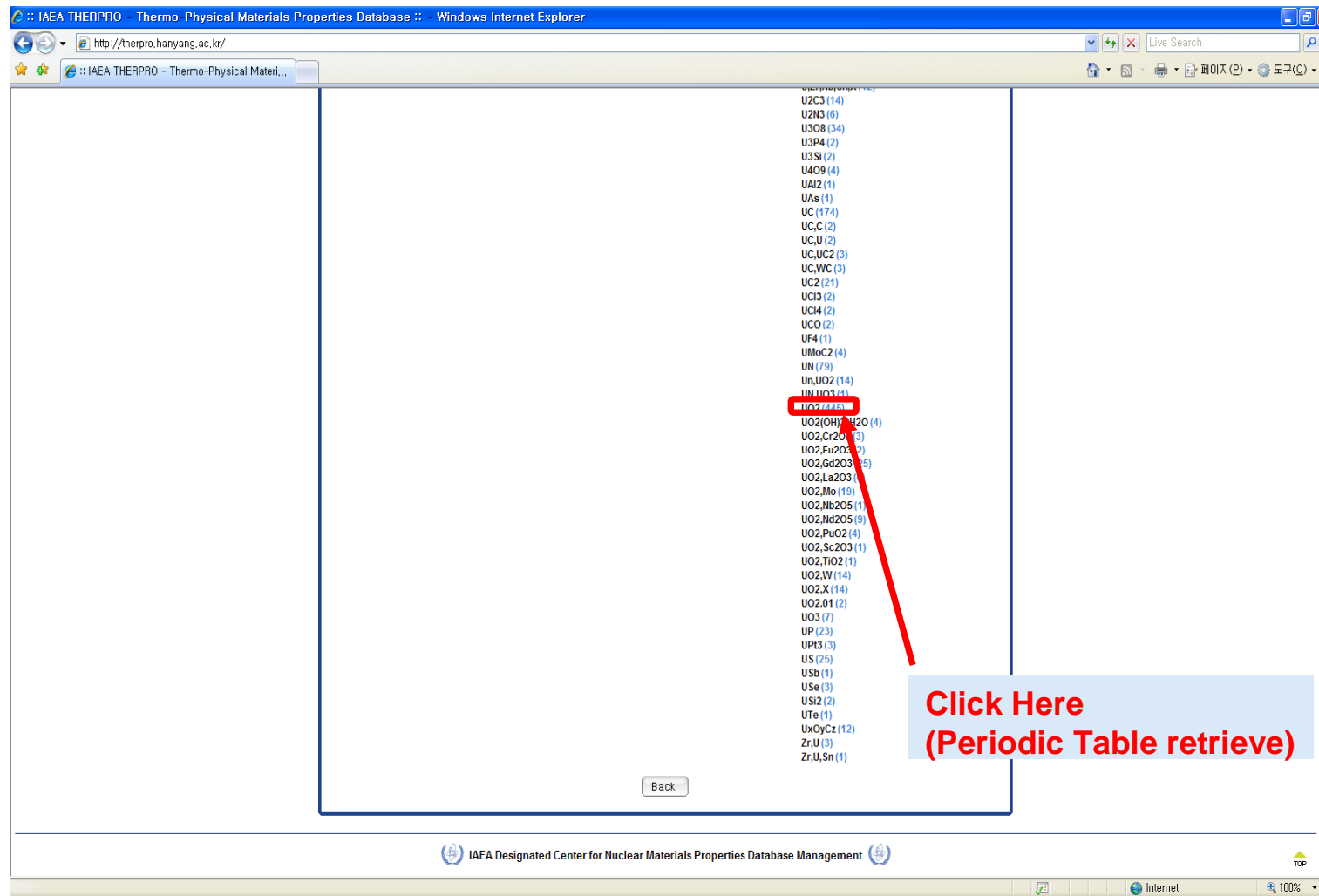


Fig 5. Compound level for Periodic Table retrieve for UO_2



1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

The screenshot shows the IAEA THERPRO website interface. The main content area is titled "Resources for : Home > Compound : UO_2 ". On the left, there is a list of general properties for UO_2 , including classification, molecular weight, density, melting and boiling temperatures, and color. On the right, there is a "Thermal Property List" with several items, each with a blue square icon and a number in parentheses. The item "Thermal Conductivity [W/cm K] (194)" is highlighted with a red rectangular box. A red arrow points from this box to a light blue callout box containing the text "Click Here (Periodic Table retrieve)".

Thermal Property List

- Thermal Conductivity [W/cm K] (194)
- Thermal Diffusivity [cm²/sec] (1)
- Emissivity (62)
- Electrical Resistance [ohm cm] (57)
- Specific Heat Capacity [J/mol K] (27)
- Enthalpy [J/mol] (14)
- Linear Thermal Expansion [%] (10)
- Differential Linear Expansion [1.E-6] (1)
- Density [g/cm³] (5)
- Reflectivity (2)
- Enthalpy [J/kg] (1)
- Specific Heat [J/kg K] (1)

Fig 6. Property level for Periodic Table retrieve for UO_2



1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO₂) cont.

The screenshot shows the IAEA THERPRO website interface. The main content area is titled "UO₂ Thermal Conductivity of uranium dioxide". It is divided into three sections: "Author", "Document List", and "Bibliographical Information".

- Author:** A list of authors including Schmidt H.E., Washington A.B.G., Gibby R.L., Harding J.H., Hetzer F.J., Laskiewicz R.A., Asamoto R.R., Craynest van J.C., Fukushima S., Hirata G.J., Hynd G.J., Martin D.G., Mohorst J.K., and Tasman H.A. The name "Fukushima S." is highlighted with a red box and a callout: "Select Here (Periodic Table retrieve)".
- Document List:** A table with columns for document numbers and checkboxes. The "Select All" checkbox is checked and highlighted with a red box and a callout: "Select Here (Periodic Table retrieve)".
- Bibliographical Information:** Contains material characterization details such as "material name: uranium dioxide", "chemical formula: UO₂", "chemical composition [mole(s)]: UO₂ 1.0000", "OIU ratio 2.0000 oxygen/metal ratio", "physical state: solid", "microstructure: polycrystalline - single phase", "crystal structure: cubic (face centered)", and "notes: lattice parameter: 5.4704A". A red box and callout "Drag Here (Periodic Table retrieve)" points to the right side of this section.
- Buttons:** "Plot" and "Back" buttons are located at the bottom of the document list section. A red box and callout "Click Here (Periodic Table retrieve)" points to the "Plot" button.

Fig 7. Author, Report, Bibliography level for Periodic Table retrieve for UO₂



1) Periodic Table search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

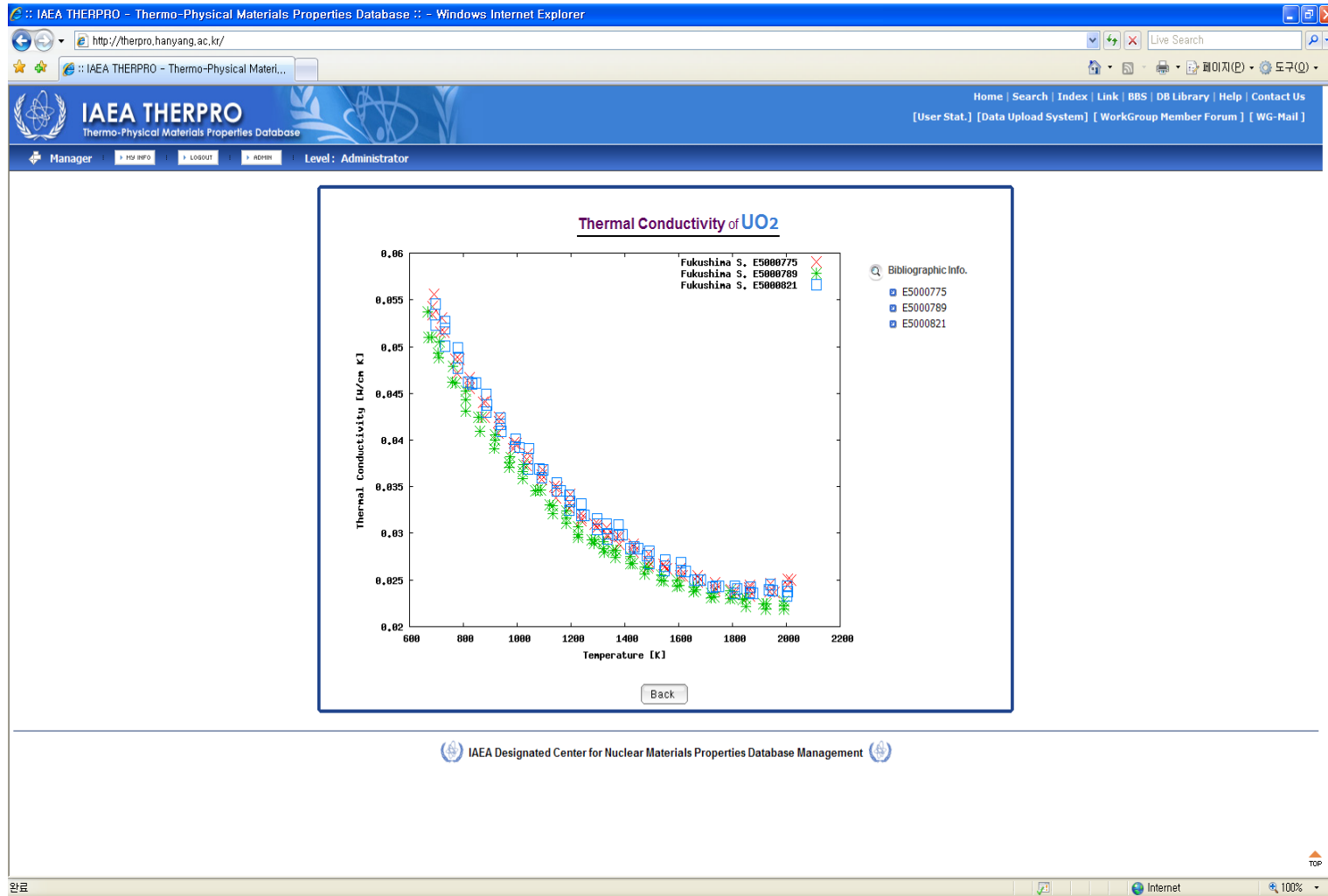


Fig 8. UO_2 thermal conductivity plot based on the Fukushima's work



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2)

The screenshot shows the IAEA THERPRO website interface. At the top, there is a navigation bar with links for Home, Search, Index, Link, BBS, DB Library, Help, and Contact Us. The 'Index' link is highlighted with a red box and a red arrow pointing to it. Below the navigation bar, there is a search area with a 'Compound' input field, a 'Property' dropdown menu, and 'Search' and 'Power Search' buttons. The main content area displays a periodic table of elements, color-coded by groups. A callout box on the right side of the periodic table contains the text 'Click Here (Index retrieve)'. The footer of the page includes the IAEA logo and the text 'IAEA Designated Center for Nuclear Materials Properties Database Management'.

Fig 9. Homepage of THERPRO for Index retrieve



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

• SmAg3	• SmSb	• Sn	• Sn,Cd	• Sn,Mg
• Sn,Pb	• Sn,Tl	• Sn,Zn	• Sn,Zr	• SnO2
• Sr	• Sr(NO3)2	• SrHfO3	• SrMoO4	• SrTiO3
• SrZrO3	• Ta	• Ta,Nb	• Ta,W	• Ta,W,Hf
• Tb	• TbSb	• Tc	• Te	• Th
• Th,U	• Th3N4	• ThC2	• ThN	• ThO2
• ThS	• Ti	• Ti,Al	• Ti,Al,Fe,Cr,Mo	• Ti,Al,Mn
• Ti,Al,Mn,X	• Ti,Al,Mo,Si	• Ti,Al,Mo,X	• Ti,Al,Si	• Ti,Al,Sn,X
• Ti,Al,Sn,Zr	• Ti,Al,Sn,Zr,X	• Ti,Al,V	• Ti,Al,V,Sn	• Ti,Al,V,X
• Ti,Al,X	• Ti,Cr,Al,X	• Ti,Cr,Fe	• Ti,Fe,Cr,Mo	• Ti,Mn
• Ti,Mo	• Ti,Sn,Al,Zr	• Ti,Sn,Zr,Al,X	• Ti,V	• Ti,V,Al,X
• Ti,V,Cr,X	• Ti,Zr	• Ti2FeCo	• Ti2O3	• Ti3Ir
• Ti4Co3Ni	• Ti4Fe3Co	• Ti4FeCo3	• TiB2	• TiBe2
• TiC	• TiC,Ni,NbC	• TiCo	• TiFe	• TiN
• TiO2	• Ti	• Tm	• Tm2O3	• U
• U(C,N)	• U(O,C)	• U,Al	• U,Cr	• U,Mg
• U,Mo	• U,Mo,Ru,X	• U,Mo,X	• U,Nb	• U,Si
• U,Ti	• U,V	• U,Zr,Mo,Ru,X	• U,Zr,Mo,Ru,X	• U2C3
• U2N3	• U3O8	• UMaC2	• U3Si	• U4O9
• UAl2	• UAs	• UO2(OH)2*H2O	• U3C,C	• UC,U
• UC,UC2	• UC,Wc	• UO2,Mo	• UC13	• UCl4
• UCO	• UF4	• UO2,TiO2	• UN	• Un,UO2
• UN,UO3	• UO2	• UO2,Mo	• UO2,Cr2O3	• UO2,Eu2O3
• UO2,Gd2O3	• UO2,La2O3	• UO2,Mo	• UO2,Nb2O5	• UO2,Nd2O5
• UO2,PuO2	• UO2,Sc2O3	• UO2,TiO2	• UO2,W	• UO2,X
• UO2.01	• UO3	• UP	• UPt3	• US
• USb	• Use	• USi2	• UTe	• V
• V,Mo	• V,Ti	• V4O7	• W	• W,Cu
• W,Re	• WC,Co	• WO2	• WO3	• Xe
• Y	• Y-Si-Al-O-N	• Y2O3	• Y2O3,TiO2	• Y3Al5O12
• Y4Co3	• Yb	• Yb,Rh,Sn	• Yb2O3	• YbZn2
• Zn	• Zn(PO3)2	• Zn,Al	• Zn,Al,X	• Zn3(PO4)2
• ZnF2	• ZnO	• Zr	• Zr,Al	• Zr,Mo
• Zr,Nb	• Zr,Sn	• Zr,Sn,Fe,Cr	• Zr,Sn,O	• Zr,Sn,X
• Zr,Ta	• Zr,Ti	• Zr,U	• Zr,U,Sn	• ZrB2

Click Here
(Index retrieve)

Fig 10. Symbol list in Index retrieve for UO_2



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO₂) cont.

The screenshot shows the IAEA THERPRO database interface. The browser address bar displays <http://therpro.hanyang.ac.kr/>. The page title is "IAEA THERPRO Thermo-Physical Materials Properties Database". The user is logged in as "Administrator". The main content area shows a search result for "UO₂" with a total of 1889 compounds listed. The results are displayed in a table with columns for "Symbol", "Compound", and "Author". A red box highlights the "Category" dropdown menu, and a red arrow points to it with the text "Click Here (Index retrieve)".

Resources for: Home > Index > Compound

Symbol Compound Author

Total 1889 Compounds Listed in THERPRO DB

[All] [Category] [Elements]

* SiC-fiber/SiC-matrix composite (1)	* (uranium-10%niobium)-25%zrcaloy 2 (12)
* 01911 alloy (1)	* 08 KP steel (4)
* 0Cr13Si2AlNbTi steel (2)	* 0Cr35Si2AlNbTi steel (2)
* 0Kh16Ni6V3T steel (1)	* 0Kh16Ni36V3T steel(EI-855) (1)
* 0Kh18Ni10T steel (1)	* 0Kh18Ni10T steel(1.4541) (2)
* 0Kh20Ni60B alloy (2)	* 0Kh21Ni78T alloy(EI-435) (2)
* 10 CrMo 9 10 (1.7380) (2)	* 10 CrMo 9 10 steel (2)
* 10 CrSiMoV 7 (1)	* 10 CrSiMoV 7 (1.8075) (2)
* 10 CrSiMoV 7 steel (1)	* 10 MnAl4 steel (1)
* 10 Ni 14 steel (1)	* 1020 low carbon steel (1)
* 10G2F steel (3)	* 11 NiMnCrMo 5 5 (1)
* 11 NiMnCrMo 5 5 (1.6919) (2)	* 11R3AMF2 steel (1)
* 12 CrMo 19 5 (1)	* 12 CrMo 19 5 (1.7362) (3)
* 12 Ni 19 steel (1)	* 1201 alloy (1)
* 12Kh18Ni10T steel (3)	* 12Kh18Ni10T steel(1.4541) (2)
* 12Kh18Ni9T steel (4)	* 12Kh1MF steel (3)
* 13 CrMo 4 4 (1.7335) (4)	* 13 CrMo 4 4 steel (3)
* 13G2AF steel (3)	* 13V-11Cr-3Al alloy (1)
* 14 MoV 6 3 (1.7715) (2)	* 14 MoV 6 3 steel (2)
* 14Kh17Ni2 steel (3)	* 15 MnNi 6 3 (1)
* 15 MnNi 6 3 (1.6210) (2)	* 15 Mo 3 (2)
* 15 Mo 3 (1.5415) (4)	* 15 Mo 3 steel (1)
* 15 NiCuMoNb 5 (1.6368) (2)	* 15 NiCuMoNb 5 steel (2)
* 16 MnCr 5 steel (1)	* 16 Mo 5 (1)
* 16 Mo 5 (1.5423) (2)	* 17 CrMoV 10 (1)
* 17 CrMoV 10 (1.7766) (2)	* 17 Mn 4 (1)
* 17 Mn 4 (1.0481) (2)	* 17 MnMoV 6 4 (1)
* 17 MnMoV 6 4 (1.8817) (2)	* 17-4 PH (2)
* 17-4PH (1.4542) (1)	* 17-7 PH (2)
* 17-7PH steel(1.4568) (1)	* 17G1SU steel (2)
* 17G1SU steel,Fe,Mn,X (1)	* 18-4-1 steel (1)
* 18Kh2Ni4MA steel (1)	* 18Kh2Ni4MA steel(1.2764) (2)
* 18NiCr steel(CrMo 250) (2)	* 18NiCr steel(CrMo 200) (2)

Fig 11. Compound list in Index retrieve for UO₂

2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

The screenshot displays the IAEA THERPRO database interface. The browser address bar shows the URL <http://therpro.hanyang.ac.kr/>. The page title is "IAEA THERPRO Thermo-Physical Materials Properties Database". The user is logged in as "Administrator".

The main content area shows the "Compound" tab selected. The "Category Path" is "Fuel Material > U Oxide > uranium dioxide". The "Category List" on the left shows "uranium dioxide (447)" selected. The "Compound List" on the right shows the following properties for UO_2 :

- Classification: oxide
- Molecular Weight: 270.028 g/mole
- Density: 10.96 g/cm³
- Melting Temperature: 2878 ± 20 °C - Boiling Temperature:
- Properties: brown-black
- Crystal Form: rhombic or cubic
- Index of Refraction:
- Sublimes:
- Color: dark brown

The "Thermal Property List" section is expanded, showing the following properties:

- Thermal Conductivity [W/cmK]
- Thermal Diffusivity [cm²/sec]
- Emissivity
- Electrical Resistance [ohm cm]
- Specific Heat Capacity [J/mol K]
- Enthalpy [J/mol]

A red box highlights "Thermal Conductivity [W/cmK]", and a red arrow points to it with the text "Click Here (Index retrieve)".

Fig 12. Compound list in Index retrieve for UO_2



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO₂) cont.

IAEA THERPRO - Thermo-Physical Materials Properties Database - Windows Internet Explorer

http://therpro.hanyang.ac.kr/thersyst/property?prop=THC&symbol=UO2&cname=uranium dioxide&path=category

UO₂ Thermal Conductivity of uranium dioxide

Author	Document List	Bibliographical Information
Harding J.H. Hetzler F.J. Laskiewicz R.A. Asamoto R.R. Craynest van J.C. Fink J.K. Fukushima S. Kamimoto M. Hirai M. Hyland G.J. Martin D.G. Hohorst J.K. Tasman H.A. Otter C. Preston S.D. Lili Z.	<input checked="" type="checkbox"/> Select All <input checked="" type="checkbox"/> E5000775 <input checked="" type="checkbox"/> E5000789 <input checked="" type="checkbox"/> E5000821	material name: uranium dioxide chemical formula: UO ₂ chemical composition [mole(s)]: UO ₂ 1.0000 O/U ratio 2.0000 oxygen/metal ratio physical state: solid microstructure: polycrystalline - single phase crystal structure: cubic (face centered) notes: lattice parameter: 5.4704Å sintered molecular mass: 270.0 g bulk density: 10.460 g/cm ³

* Click the Author Name and Document Number.

Click Here (Index retrieve)

Plot Close

IAEA Designated Center for Nuclear Materials Properties Database Management

Fig 13. Author, Report, Bibliography level for Compound list retrieve for UO₂



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

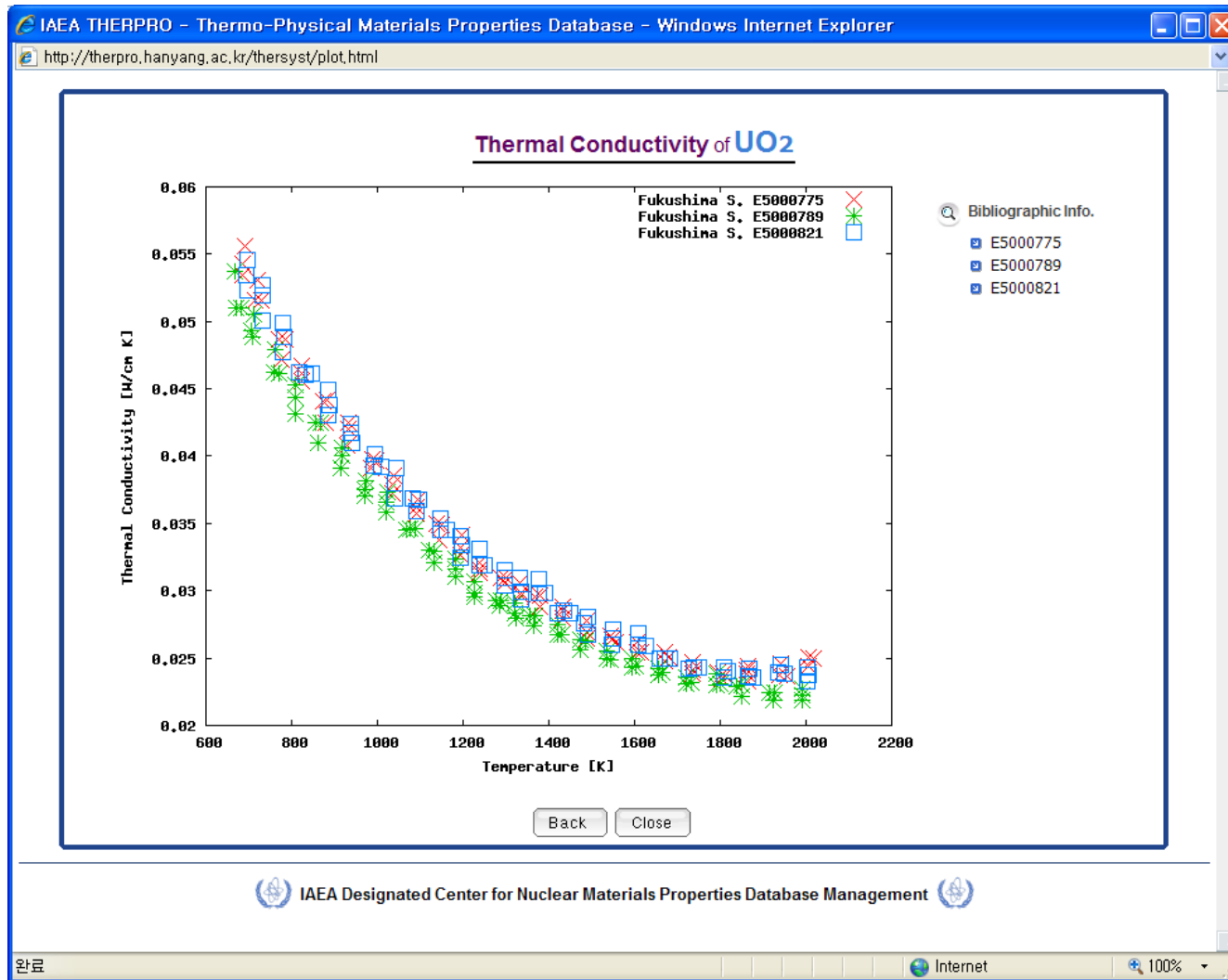


Fig 14. UO_2 thermal conductivity plot based on the Fukushima's work

2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.

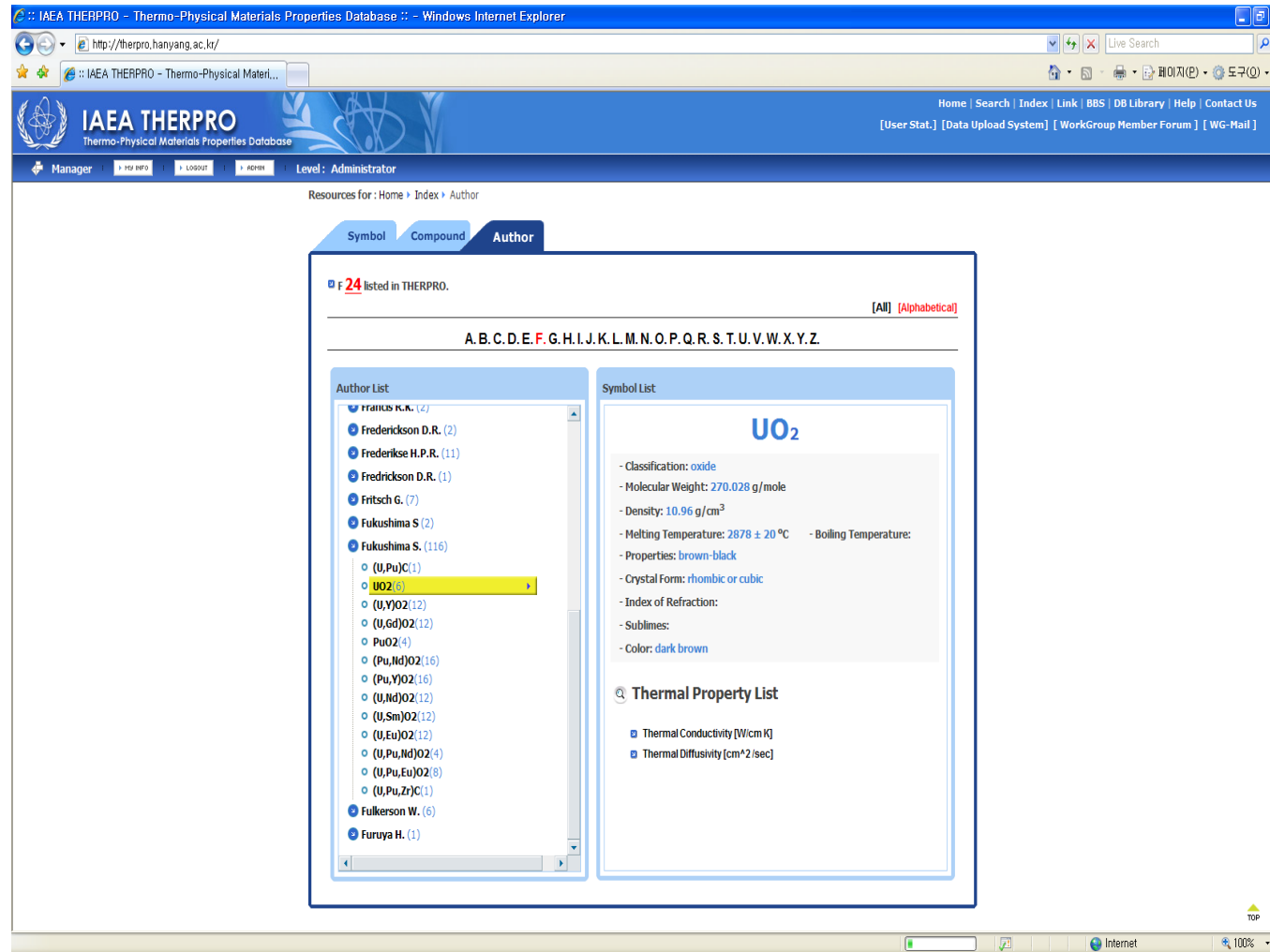
The screenshot shows the IAEA THERPRO website interface. The browser address bar displays 'http://therpro.hanyang.ac.kr/'. The page title is 'IAEA THERPRO Thermo-Physical Materials Properties Database'. The user is logged in as 'Administrator'. The main content area shows 'Resources for: Home > Index > Author'. There are three tabs: 'Symbol', 'Compound', and 'Author', with 'Author' selected. Below the tabs, it says 'Total 779 listed in THERPRO.' and a dropdown menu is set to 'Alphabetical'. A red arrow points to the 'Alphabetical' dropdown, and a red text box next to it says 'Click Here (Index retrieve)'. The author list is displayed in a grid format with columns of names.

Symbol	Compound	Author
Total 779 listed in THERPRO.		
[All] Alphabetical		
Adler P.	Bibliography	Abdusalamova M.N.
Amasovich E.S.	Affortt C.	Abeles B.
Andrew J.F.	Amato I.	Alexander C.A.
Arbeitskreis	Andrianova V.G.	Alexas A.
Arkipov V.A.	Arbeitskreis Thermophysik	Andon R.J.L.
Ashley T.S.	Arthur J.S.	Arajs S.
Baramashvili I.A.	Atroschenko E.S.	Arutyunov A.V.
Bal J.G.	Baker D.E.	Asamoto R.R.
Basak U.	Banchla S.N.	Backlund N.G.
Bauhofer W.	Batalin G.I.	Baleva M.I.
Belenki G.L.	Baxter W.G.	Barnes B.T.
Benedict U.	Bell I.P.	Bates J.L.
Bhattach H.	Bentsen L.D.	Bel'skaya E.A.
Biran de A.	Bhude V.G.	Bendick W.
Bocker S.	Bird B.L.	Bethoux O.
Bollnath F.	Bode K.H.	Binkele L.
Brandon J.R.	Bonnerot J.M.	Bober M.
Brennan J.J.	Brandt N.B.	Bogaard R.H.
Bruet M.	Brett N.H.	Boysel R.M.
Buravoy S.E.	Bryant C.A.	Brauner J.
Cabannes F.	Butera R.A.	Brown W.B.
Casey D.N.	Butler C.P.	Buntebarth G.
Charles J.	Calza-Bini A.	Byron Brown W.
Chen Y.	Casey J.T.	Carniglia S.C.
Cho H.K.	Chasnov M.G.	Chang Y.A.
Collins J.G.	Chekhovskii V. Ya.	Chelkowski A.
Cook M.	Chevner J.	Chirigos J.N.
Crane J.	Chioti P.	Clifton D.G.
Czochralski J.	Chupina L.I.	Conway J.B.
Danna J.	Chyung K.	Counsel J.F.
Davey P.O.	Colvin R.V.	Culbert H.V.
De Smet A.	Connelly D.L.	Daniel J.L.
	Cote P.J.	Daudin B.
	Craynest van J.C.	De Hovton C.H.
	D.M.Bailey	
	Dauchier M.	
	de Baranda P.S.	
	De Coninck R.	

Fig 15. Author list in Index retrieve for UO_2



2) Index search (Example: Author's (B.C. AAA) work on thermal conductivity of UO_2) cont.



The screenshot displays the IAEA THERPRO website interface. The browser address bar shows the URL <http://therpro.hanyang.ac.kr/>. The page header includes the IAEA logo and the text "IAEA THERPRO Thermo-Physical Materials Properties Database". Navigation links for "Home", "Search", "Index", "Link", "BBS", "DB Library", "Help", and "Contact Us" are present. A user status bar indicates "Level: Administrator".

The main content area is titled "Resources for: Home > Index > Author". It features three tabs: "Symbol", "Compound", and "Author", with "Author" selected. A message states "F 24 listed in THERPRO." and a link for "[All] [Alphabetical]" is provided. Below this, an alphabetical index is shown with "F" highlighted.

The "Author List" panel on the left contains the following entries:

- Francis R.C. (2)
- Frederickson D.R. (2)
- Frederikse H.P.R. (11)
- Fredrickson D.R. (1)
- Fritsch G. (7)
- Fukushima S. (2)
- Fukushima S. (116)
 - (U,Pu)C(1)
 - UO2 (6)**
 - (U,Y)O2(12)
 - (U,Gd)O2(12)
 - PuO2(4)
 - (Pu,Nd)O2(16)
 - (Pu,Y)O2(16)
 - (U,Nd)O2(12)
 - (U,Sm)O2(12)
 - (U,Eu)O2(12)
 - (U,Pu,Nd)O2(4)
 - (U,Pu,Eu)O2(8)
 - (U,Pu,Zr)C(1)
- Fulkerson W. (6)
- Furuya H. (1)

The "Symbol List" panel on the right displays "UO2" and provides the following properties:

- Classification: oxide
- Molecular Weight: 270.028 g/mole
- Density: 10.96 g/cm³
- Melting Temperature: 2878 ± 20 °C - Boiling Temperature:
- Properties: brown-black
- Crystal Form: rhombic or cubic
- Index of Refraction:
- Sublimes:
- Color: dark brown

The "Thermal Property List" section includes:

- Thermal Conductivity [W/cm K]
- Thermal Diffusivity [cm²/sec]

Fig 16. Author list in Index retrieve for UO_2



3) Power Search

The screenshot shows a web browser window titled "IAEA THERPRO - Thermo-Physical Materials Properties Database". The address bar shows the URL "http://therpro.hanyang.ac.kr/". The page header includes navigation links: Home | Search | Index | Registration | Link | BBS | DB Library | Help | Contact Us, and a link to the WorkGroup Member Forum. A user menu shows "Manager" with options for "MY INFO", "LOGOUT", and "ADMIN", and a "Level: Administrator" indicator.

The main content area features a "Power Search" form with the following fields:

- Chemical Formula:
- Compound Name:
- Property:
- Author:
- Year of Publication: -

A "Search" button is located below the form fields.

At the bottom of the page, there is a footer with the text "IAEA Designated Center for Nuclear Materials Properties Database Management" and a "TOP" link.

4. THERPRO UPCOMING ACTIVITIES

❑ System Upgrade

- Supported by Korean government
- Includes:
 - Hardware and software
 - DB management and operating system
 - Index Search system: Author index search system
 - DB system protection and user support system
 - Materials re-categorization
 - Advisory work group forum modification

❑ Creation of an Advisory Group to supervise the quality of the data included

❑ Data Update & Addition of WCR new data

❑ Expanding the THERPRO DB to include materials from other reactor types

- Fast Reactors, Gas Cooled Reactors, etc
- The THERPRO infrastructure would be made available to other groups interested in creating DBs for their data





Thank you!