



Dr.  
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# RESEARCH DATA MANAGEMENT SYSTEMS IN MATERIALS SCIENCE BASED ON FAIR PRINCIPLES

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- INF Project in CRC/TRR 247:
  - Defining requirements
  - Database schema and flexibility
  - Current state: implemented features and future plans
  - Live Demonstration
- Q&A.

# RDMS in Chemistry-related Domains: Requirements

INF(N)

## Requirements (functional capabilities):

## Priorities (SFS): Security + Flexibility + Scalability

- Support for multiple **Tenants**;
- Implement **User Registration** (including e-mail verification) and **Authorization**;
- Implement Administrative Interface to **Control Users and Groups**;
- Establish **Predefined Roles** (Administrator / PowerUser / User) with corresponding permissions;
- Ensure **Data Access Policy** (public / protected / private) for all stored objects based on Object Access Level;
- **Adjust Functionality** of RDMS according to authorized user role (Administrator / PowerUser / User);
- **Upload and Store Objects** (documents) with minimalistic mandatory metadata;
- Provide **Flexible Tree Classification** for stored documents (projects / organizational structure);
- Provide means to **Support Chemical Entities** data types: systems, compositions, crystal structures;
- Enable to **Interlink Objects** manually (associative objects) and show the resulting reverse associations;
- Flexibility: implement **Extended Properties for Objects** and support search on them;
- **Import and Export** object table properties from/to Excel; support table properties templates;
- Provide **Search Interface** on chemical entities and objects with respect to user access level;
- Known object types **Bulk Import from CSV** files (with CSV-schema validation);
- Flexibility: enable to easily **Introduce Additional Object Types** with predefined mandatory fields set\*;

## To be done:

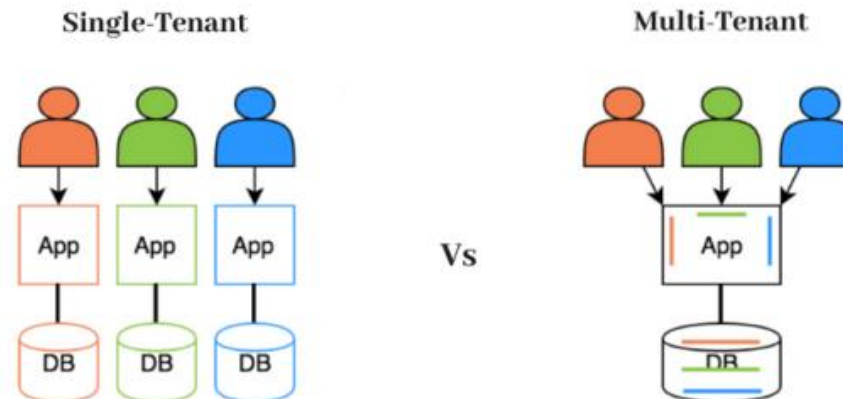
- Provide **Reports / Charts / Diagrams** on stored data in various aspects;
- **API** to upload data from measurement devices (Bandgap, Resistance, etc...).

# RDMS: Multiple Tenant Support

## What is Tenant?

### Short answer:

Tenant – separate (distinct) instance of a software application that is used by a single organization or group of users.



### Long answer:

Tenant is a customer account that has its own set of users, data, and configuration settings, and is isolated from other tenants in the same software application. This concept is commonly used in Software as a Service (**SaaS**) applications, where a single software application is hosted in the cloud and is made available to multiple customers as separate tenants. This allows each customer to have their own instance of the application, with their own data, settings, and customizations, while still sharing the underlying infrastructure and resources of the application

### Conclusion:

Tenants are useful for separate SFB projects / workgroups / materials data repositories. For example:

- <https://demo.mdi.ruhr-uni-bochum.de/>
- <https://inf.mdi.ruhr-uni-bochum.de/>
- <https://crc247.mdi.ruhr-uni-bochum.de/>

Every tenant must have a unique URL!

# RDMS Database

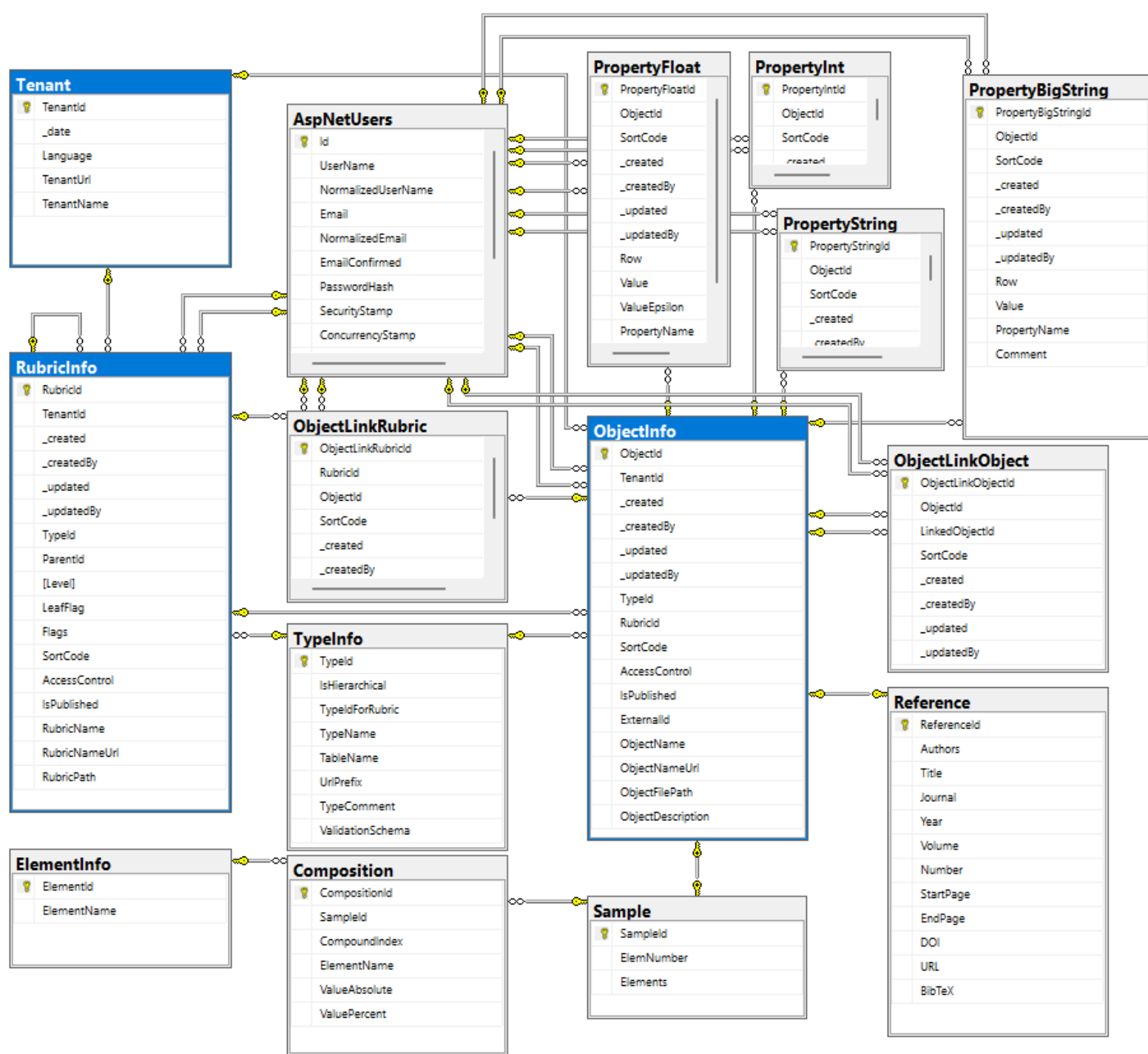
Tenants (independent systems):

TenantId	_date	La...	TenantUrl	TenantName
1	2022-11-09 12:0...	en	inf.mdi.ruhr-uni-bochum.de	CRC/TRR247
2	2023-01-04 14:4...	en	dim.mdi.ruhr-uni-bochum.de	DIMENSION
3	2023-01-16 18:3...	en	demo.mdi.ruhr-uni-bochum.de	DEMO

Every tenant must have a unique URL!

Data Types (can be shared among tenants):

Typeld	IsHierarchical	TypeldForRubric	TypeName	TableName
1	True	NULL	Organisation Structure	RubricInfo
2	True	NULL	Project	RubricInfo
3	False	2	Literature Reference	Reference
4	False	2	Publication	Reference
5	False	2	Substrate	ObjectInfo
6	False	2	Sample	Sample
7	False	2	Raw Document	ObjectInfo
8	False	2	Composition	Composition
9	False	2	Tag	ObjectInfo
10	False	2	System	Sample



# RDMS: Registration and Authorization

Application access level is determined by the current user context.

**Two-way registration** (choose any):

- using **external provider** (OpenID Connect), e.g. Google (external authentication authority is used, no credentials are stored locally).
- using **local account** (credentials are stored internally);

In both cases, an e-mail address is required, and its successful verification is a prerequisite for access.

## Log in

Use a local account to log in.

Use another service to log in.



Email

Password

Remember me?

Log in

[Forgot your password?](#)

[Register as a new user](#)

[Resend email confirmation](#)

### Confirm your email

From: "MDI robot" <mdi-robot@ruhr-uni-bochum.de>

To: [Redacted]

Please confirm your account by [clicking here.](#)

### Confirm email

Thank you for confirming your email.

After e-mail confirmation, the user is considered active, but does not have an assigned user group.

# RDMS: Identity User Control Interface

## Features:

- Registered users management
- Roles management
- Claims management

### User List

New Edit Delete Password Search:

Id ↑↓	Email	UserName	Name	Roles	Locked
1	vic.dudarev@gmail.com	vic.dudarev@gmail.com	Victor Dudarev	User,PowerUser,Administrator	
2	vic_dudarev@mail.ru	vic_dudarev@mail.ru	Victor Dudarev	User	
3	lbmdirub@gmail.com	lbmdirub@gmail.com	Lars Banko	User,PowerUser,Administrator	
4	alfredgludwig@gmail.com	alfredgludwig@gmail.com	Alfred Ludwig	User,PowerUser,Administrator	
5	felix.thelen.rub@gmail.com	felix.thelen.rub@gmail.com	Felix Thelen	User,PowerUser	

Claim is a piece of information (key-value pair) that describes a user. Claims are stored in a user's identity and can be used to determine what actions a user is authorized to perform, such as accessing certain pages or resources.

### Edit User

User Roles Claims

Type	Value	Action
Name	Alan Savan	<a href="#">Remove</a>
_SputterRate.read	1	<a href="#">Remove</a>
_SputterRate.write	1	<a href="#">Remove</a>
<input type="text"/>	<input type="text"/>	<a href="#">Add</a>

### Edit User

User Roles Claims

Administrator  
 PowerUser  
 User

## Roles:

- **User:**
  - read-only access to public and protected data
- **PowerUser:**
  - read-only access to public and protected data (+ private data, created by the current user)
  - add data (+ write access to data, created by the current user)
- **Administrator:**
  - full access to all data (CRUD)
  - user management
- **Anonymous (== registered user with no roles assigned):**
  - read-only access to public data only (be aware: internet search engines will index public data)

Role List		
<input type="button" value="New"/>	<input type="button" value="Edit"/>	<input type="button" value="Delete"/>
Id	↑↓	Name
1		User
2		PowerUser
3		Administrator



# RDMS: Setting the Object Access Level

## What is an Object?

Object (=document) is a data entry within RDMS that has user-defined access level and reflects an object of the real world (e.g. sample) or its model. Ultimately, object has its unique Web page (with unique URL address).

**To establish data access policy Data Access Levels are introduced in RDMS.**

## Three Access Levels:

- **Public** (default, we are doing open science, FAIR, aren't we?):
  - objects are available to everybody regardless of authorization (visible to internet search engines);
- **Protected** (visible to the community only):
  - objects are visible to the community (available to authorized users with at least **User** role assigned);
- **Private** (person's secret, but open for Administrators):
  - objects are visible to the user-creator (at least **PowerUser** role assigned);
  - objects are visible to all users of **Administrator** role.

# RDMS: Adjust Functionality According to User Permissions

User credentials (role) affects user interface: <https://demo.mdi.ruhr-uni-bochum.de/rubric/binary-compounds>

### User1 (User role)

### PowerUser1 (PowerUser role)

### Admin1 (Administrator role)

**Authorized CRC Community**

User (no role) = Anonymous (search engine)

Visit <https://demo.mdi.ruhr-uni-bochum.de/object/ag2s-4870>

- User => **access granted**
- Anonymous => **access denied**

access denied

**Preconditions:**

Ag<sub>2</sub>O created (**public**) by Admin1

Ag<sub>2</sub>S created (protected) by PowerUser1

Ag<sub>2</sub>Se created (**private**) by PowerUser1

Accessible (visible)

Denied (hidden)

# RDMS: Upload and Store Documents (with minimalistic mandatory metadata)

ObjectInfo			
	Column Name	Data Type	Allow Nulls
	ObjectId	int	<input type="checkbox"/>
	TenantId	int	<input type="checkbox"/>
	_created	datetime	<input type="checkbox"/>
	_createdBy	int	<input type="checkbox"/>
	_updated	datetime	<input type="checkbox"/>
	_updatedBy	int	<input type="checkbox"/>
	TypeId	int	<input type="checkbox"/>
	RubricId	int	<input checked="" type="checkbox"/>
	SortCode	int	<input type="checkbox"/>
	AccessControl	int	<input type="checkbox"/>
	IsPublished	bit	<input type="checkbox"/>
	ExternalId	int	<input checked="" type="checkbox"/>
	ObjectName	varchar(128)	<input type="checkbox"/>
	ObjectNameUrl	varchar(256)	<input type="checkbox"/>
	ObjectFilePath	varchar(256)	<input checked="" type="checkbox"/>
	ObjectFileHash	varchar(128)	<input checked="" type="checkbox"/>
	ObjectDescription	varchar(256)	<input checked="" type="checkbox"/>
			<input type="checkbox"/>

- Unique Object Identifier (**assigned automatically**), primary key
- Tenant Identifier (**assigned automatically** based on URL address)
- User who created the object and date with time (**automatically**)
- User who modified the object and modification date and time (**auto**)
- Object type reference (determined by user on object creation)
- Project (tree-structure) reference (can specified by user on object creation)
- Code to define a certain order in list of objects (**auto**, can be changed)
- One of predefined Object Access Levels: **public<sub>def</sub>** / protected / private
- Name of the object (must be specified)**
- Relative URL for page to access object (**auto formed**; can be changed)
- Reference to Data File uploaded to system (uploading by choice)
- SHA-256 file hash (must be **unique** within every tenant)
- Object Description (can be empty, as all nullable attributes above)

# RDMS: Data Types (hierarchies and lists)

## Data Types

IsHierarchical = True

**Hierarchical**  
(tree types)

IsHierarchical = False

**List**  
(list types)

All types are extendable (stored in TypeInfo)

TypeId	IsHierarchical	TypeIdForRubric	TypeName	TableName
1	True	NULL	Organisation Structure	RubricInfo
2	True	NULL	Project	RubricInfo
3	False	2	Literature Reference	Reference
4	False	2	Publication	Reference
5	False	2	Substrate	ObjectInfo
6	False	2	Sample	Sample
7	False	2	Raw Document	ObjectInfo
8	False	2	Composition	Composition
9	False	2	Tag	ObjectInfo
10	False	2	System	Sample

**Rubrics** (RubricInfo table) types:

- Project
- Organization Structure
- ++ (extendable)

**Objects** (ObjectInfo table) and all derived (non-hierarchical) types:

- Reference
- Sample
- Composition
- ++ (extendable)

# RDMS Tree Types: control and display

CRC/TRR247 Database Search **Tree Edit** List Edit

## Tree Editor

Select hiererchical type to edit:

- [Organisation Structure](#)<sup>33</sup> RubricInfo [Hierarchy of organisatioanal unit within the tenant]
- [Project](#)<sup>31</sup> RubricInfo [Project is a container to include all relevant information (publications, references, samples, measurements, etc)]

1st Level Project

2nd Level Project

3rd Level Project

3rd Level Project2

4th Level Project2\_1

4th Level Project2\_2

5th Level Project2\_2\_1

5th Level Project2\_2\_2

5th Level Project2\_2\_3

4th Level Project2\_3

3rd Level Project3

2nd Level Project2

2nd Level Project3

### 4th Level Project2\_2

Take a look at subprojects:

- 5th Level Project2\_2\_1
- 5th Level Project2\_2\_2
- 5th Level Project2\_2\_3

## Display for users in Web Application

1st Level Project	2nd Level Project	3rd Level Project	
Publications	2nd Level Project2	3rd Level Project2	4th Level Project2_1
Samples	2nd Level Project3	3rd Level Project3	4th Level Project2_2
Sputtering Rates			4th Level Project2_3
			5th Level Project2_2_1
			5th Level Project2_2_2
			5th Level Project2_2_3

### Project

Name	Id	Access	Actions
▼ 1st Level Project	47	0 Public	
▼ 2nd Level Project	48	0 Public	
▶ 3rd Level Project	49	0 Public	
▼ 3rd Level Project2	56	0 Public	
4th Level Project2_1	63	0 Public	
▼ 4th Level Project2_2	64	0 Public	
5th Level Project2_2_1	66	0 Public	
5th Level Project2_2_2	67	0 Public	
5th Level Project2_2_3	68	0 Public	

### Editing 4th Level Project2\_1 [Id=63]

Name:

name of the node

Parent Id:

Don't change it if you are not sure what you are doing

Sort Code:

within a parent all children are sorted by this number (ascending)

Access Control (accessibility):

protected - to authorized users; private - to you only

### Control (admin):

- Name
- Parent Id
- Sort Code
- Access

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# RDMS List Types: control

DEMO Database Search Tree Edit **List Edit**

## List Editor

Select list type to edit:

- Literature Reference**<sup>1861</sup> Reference [Information about publications that are considered useful within a project or to which you are referecing in publications]
- Publication**<sup>0</sup> Reference [Publication (published or is going to be published material accouring to current work)]
- Substrate**<sup>2</sup> ObjectInfo [Wafer material]
- Sample**<sup>1</sup> Sample [Sample information (sputter deposition)]
- Raw Document**<sup>1</sup> ObjectInfo [Data file on disk in any format (file extension required to identify MIME-type)]
- Composition**<sup>4749</sup> Composition [Composition information (compound)]
- Tag**<sup>6</sup> ObjectInfo [Tags for assigning to objects]
- System**<sup>0</sup> Sample [Chemical system]

List of all objects (of type Composition):

K <sub>3</sub> Bi <sub>2</sub> Br <sub>9</sub>	0	Public	K <sub>3</sub> Bi <sub>2</sub> Br <sub>9</sub>		
K <sub>3</sub> Bi <sub>2</sub> I <sub>9</sub>	0	Public	K <sub>3</sub> Bi <sub>2</sub> I <sub>9</sub>		
K <sub>3</sub> CdB <sub>5</sub> O <sub>10</sub>	0	Public	K <sub>3</sub> CdB <sub>5</sub> O <sub>10</sub>		

### Editing object K<sub>3</sub>Bi<sub>2</sub>I<sub>9</sub> (Composition)

**Type** Composition

**Object ID** 3789 ExternalId: 2631

**Created** 2/1/2023 3:33:13 PM

**Created By** VicD

**Rubric ID**

**Sort Code (asc)**

**Access Control (accessibility)**

**Name**

**URL (unique)**

**File Path**  No file chosen

**Description**

**Chemical System (As-Ga)**  elements

	Absolute	or	Percentage	%	
K	<input type="text" value="3"/>	or	<input type="text" value="percentage"/>	%	
Bi	<input type="text" value="2"/>	or	<input type="text" value="percentage"/>	%	
I	<input type="text" value="9"/>	or	<input type="text" value="percentage"/>	%	

### Control (common to all objects):

- Rubric Id;
- Sort Code;
- Access;
- Name;
- URL (adjustable\*);
- Attach File (document);
- Description.

1

2

### Type specific control (e.g. Composition):

- Chemical System;
- Composition (elements containment).

Select elements

Chosen elements: Bi-I-K



# RDMS List Types: display

DEMO Database Search Tree Edit List Edit Hello vic.dudarev@gmail.com! Logout

Bandgap measurement

Elements

**Binary Compounds**

Ternary Compounds

Quaternary Compounds

Multi-Component Compounds

Literature References

Sputter Rates

Add Project

Bandgap measurement / Binary Compounds

## Binary Compounds

Add Subproject

**Ag<sub>2</sub>O** [Public Composition](#)

Ag<sub>2</sub>O

[Ag<sub>2</sub>S](#) [Protected Composition](#)

Ag<sub>2</sub>S

[Ag<sub>2</sub>Se](#) [Private Composition](#)

Ag<sub>2</sub>Se

DEMO Database Search Tree Edit List Edit Hello vic.dudarev@gmail.com! Logout

Bandgap measurement

Elements

**Binary Compounds**

Ternary Compounds

Quaternary Compounds

Multi-Component Compounds

Literature References

Sputter Rates

Add Project

Bandgap measurement / Binary Compounds / Ag<sub>2</sub>O

## Composition Ag<sub>2</sub>O

Type: Composition

Objectid: 4605 [Externalid: 3516]

Created: 2/1/2023 3:33:16 PM by ViCD

Access: Public

Updated: 3/1/2023 5:27:59 PM by Victor Dudarev

Name: Ag<sub>2</sub>O

Description: Ag<sub>2</sub>O

Chemical System (As-Ga): Ag-O

### Composition

Element	Absolute	Percentage
Ag	2	66.667 %
O	1	33.333 %

### Associated Objects

- [Landolt-Bornstein Numerical Data and Functional Relationships in Scie](#)

Visibility depends on user privileges

## UI Experience:

- Select project (rubric with objects)
- Select object of interest
- Follow the link and explore object data and properties

## The table

Download properties in Excel

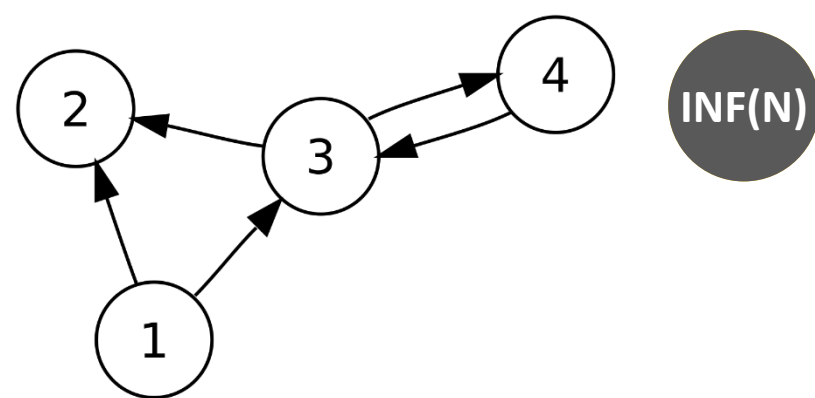
Choose File No file chosen

Upload / Replace table from Excel

CrystalSystem	SpaceGroup	Temperature	E	IsCalculated	ReferencId
Cubic	Pm3m	300	0.64	0	27
Cubic	Pm3m	293	1.2	0	30
Cubic	Pm3m	293	1.2	0	33
Cubic	Pm3m	223	1.4	0	33
Cubic	Pm3m	4	1.571	0	33
Cubic	Pm3m	143	1.6	0	33

<https://demo.mdi.ruhr-uni-bochum.de/object/ag2o-4605>

# RDMS: Interlink Objects



Example: literature reference for published data on composition:

## Associated Objects

- [Strehlow W.H.,Cook E.L. Compilation of Energy Band Gaps in Elemental a](#)  
Strehlow W.H.,Cook E.L. Compilation of Energy Band Gaps in Elemental and Binary Compound Semiconductors and Insulators [Literature Reference]

## Associated Objects

- Strehlow W.H.,Cook E.L. Compilation of Energy Band Gaps in Elemental a [Literature Reference] ✕
- Abudoureheman M.,Han S.,Wang Y.,Liu Q.,Yang Z.,Pan S. Three Mixed-Alka [Literature Reference] ✕

Save

3

Drag&Drop objects here

Search Literature Reference 1 ▼ objects: wang 2 Search

[Abudoureheman M.,Han S.,Wang Y.,Lei B.-H.,Yang Z.,Pan S. A3Sr2P7O21 \(A \[Literature Reference\]](#)

[Abudoureheman M.,Han S.,Wang Y.,Liu Q.,Yang Z.,Pan S. Three Mixed-Alka \[Literature Reference\]](#)

[Abudurusuli A.,Huang J.,Wang P.,Yang Z.,Pan S.,Li J. Li4MgGe2S7: The F \[Literature Reference\]](#)

## To add associated objects:

- 0) Go to “List edit” or select object to edit
- 1) Select associated object type (optional filter)
- 2) Input search phrase, contained in the Name of desired object to be associated
- 3) Drag & Drop desired object(s) from search result list to the area / adjust list
- 4) Save changes

**Important:** Reverse associations allow to browse reverse-directional associations, such as finding all compounds mentioned in a particular literature reference.



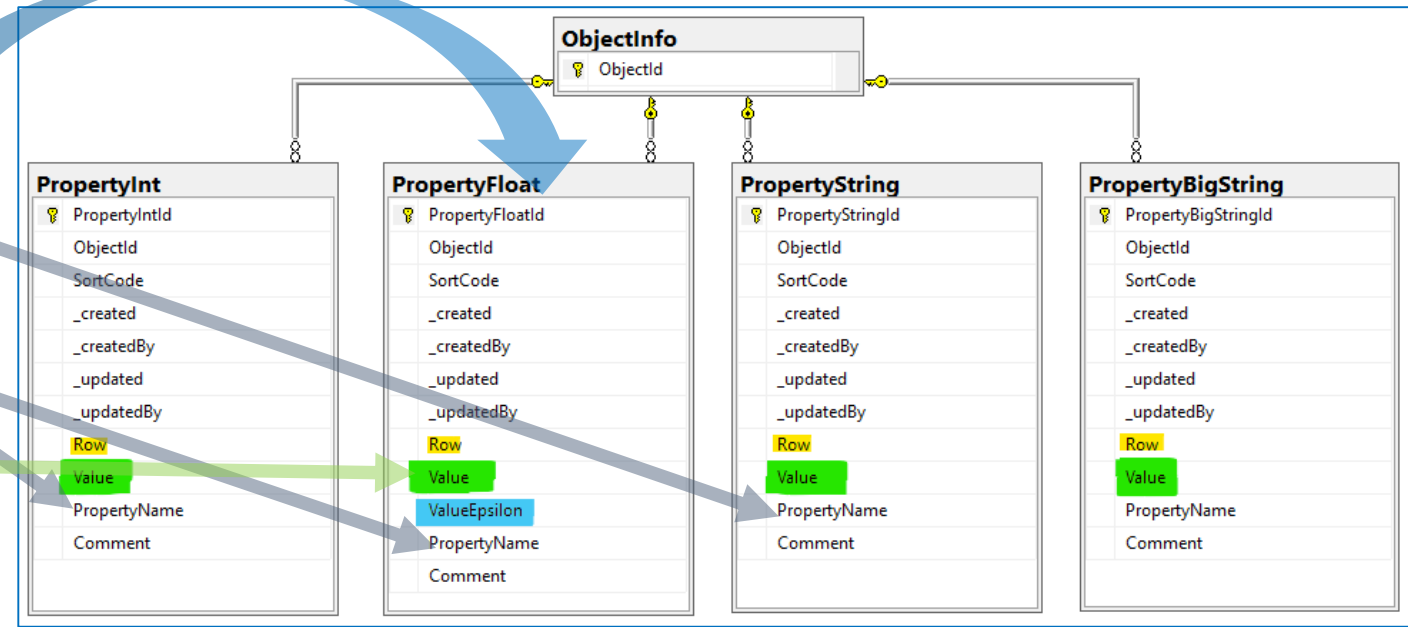
# RDMS Object's Flexibility: Extended Properties

Use case: add additional properties values (or even a table) to object and afterward make search on them.

OR  
When the existing fields set is not enough...

Task: associate table with object

Modification	CrystalSystem	SpaceGroup	Temperature	E	IsCalculated	Referenceld	Comment
α	Monoclinic	P2 <sub>1</sub> /c	300	0.87	0	581	Optical absorption spectroscopy. Direct transition. Thin film, single crystal
Row=1							
β	Cubic	Im3(-)m	77	1.23	0	581	Photoconduction. Thin film, polycrystalline
Row=2							
β	Cubic	Im3(-)m	296	1.03	0	581	Photoconduction. Thin film, polycrystalline
Row=3							



String x3    Float x2    Int x2    String

Solution: Decompose the table so, that each cell value is stored in Property\* table according to cell value type.

Important attributes:

- **PropertyName** – contains column name
- **Value** – contains cell value
- **Row** – contains row number (1, 2, 3, ...). If no row number specified – value is treated as object's property

# RDMS Extended Properties Control





Extended Properties Control for object is available according to the object access managements in administration panel for objects.

## Property values









Floating-point properties

Row	Name	Value	Epsilon	Comment	
1	Temperature	300		38985	 
1	E	0.87		38985	 
2	Temperature	77		38986	 

Integer properties

Row	Name	Value	Comment	
1	IsCalculated	0	38985	 
1	ReferenceId	581	38985	 

String properties

Row	Name	Value	Comment	
1	Modification	&alpha;	38985	 
1	CrystalSystem	Monoclinic	38985	 
1	SpaceGroup	P2<sub>1</sub>/c	38985	 
1	Comment	Optical absorption spectroscopy. Direct transition. Thin film, single crystal	38985	 

### Editing

**Name**  
  
name of the property

**Value**  
  
specify the value of the property [Extend](#)

**Value Epsilon**  
  
specify the measurement error of the property

**Sort Code**  
  
within a list all properties are sorted by this number (ascending)

**Row**  
  
row number to display a value in a virtual table (1+)

**Comment**  
  
any comments in a free form

# RDMS Extended Properties: Export and Import

**Task:** make properties modification easy

**Steps:**

- 1) **Download** data
- 2) Open in Excel and **edit**
- 3) **Upload** changed data back to the RDMS

The table

Download properties in Excel

Choose File No file chosen

Upload / Replace table from Excel

Modification	CrystalSystem	SpaceGroup	Temperature	E	IsCalculated	ReferenceId	Comment
$\alpha$	Monoclinic	P2 <sub>1</sub> /c	300	0.87	0	581	Optical absorption spectroscopy. Direct transition. Thin film, single crystal
$\beta$	Cubic	Im3(-)m	77	1.23	0	581	Photoconduction. Thin film, polycrystalline
$\beta$	Cubic	Im3(-)m	296	1.03	0	581	Photoconduction. Thin film, polycrystalline

**Import**  
(requires permissions)

**Export**

Ag2S - Excel

Page Layout Formulas Data Review View Automate Help

Calibri 11

General Conditional Formatting Format as Table Cell Styles

Insert Delete Format

Undo Clipboard Font Alignment Number Styles Cells Editing Analysis

Modification	CrystalSystem	SpaceGroup	Temperature	E	IsCalculated	ReferenceId	Comment
&alpha;	Monoclinic	P2<sub>1</sub>/c	300	0.87	0	581	Optical absorption spectroscopy. Direct transition. Thin film, single crystal
&beta;	Cubic	Im3(-)m	77	1.23	0	581	Photoconduction. Thin film, polycrystalline
&beta;	Cubic	Im3(-)m	296	1.03	0	581	Photoconduction. Thin film, polycrystalline

<https://demo.mdi.ruhr-uni-bochum.de/object/ag2s-4870>

<https://demo.mdi.ruhr-uni-bochum.de/object/ag2s-4870>

# RDMS Extended Properties: Templates for data types

INF(N)

**Task:** define Template for properties with respect to particular type

### List Editor

Select list type to edit/create:

- [Literature Reference](#)<sup>1981</sup> Reference [Information about publications that are considered useful within a project or to which you are referencing in publications]
- [Publication](#)<sup>0</sup> Reference [Publication (published or is going to be published material according to current work)]
- [Substrate](#)<sup>3</sup> ObjectInfo [Wafer material]
- [Sample](#)<sup>4</sup> Sample [Sample information (sputter deposition)]
- [Raw Document](#)<sup>4</sup> ObjectInfo [Data file on disk in any format (file extension required to identify MIME-type)]
- [Composition](#)<sup>4142</sup> Composition [Composition information (compound)]
- [Tag](#)<sup>21</sup> ObjectInfo [Tags for assigning to objects]
- [System](#)<sup>0</sup> Sample [Chemical system]
- [Sputter Rate](#)<sup>2</sup> Sample [Sputter Rate of pure element regarding power and other conditions]





**Steps:**

1) After creating a data type (e.g. based on existing table) **create a “\_Template” object** of given type: <https://demo.mdi.ruhr-uni-bochum.de/adminobject/list/11>

2) **Add Columns** of desired table to corresponding Properties (w.r.t. data type: Float / Int / String / BigString) **with Row=-1** – predefined template:

<https://demo.mdi.ruhr-uni-bochum.de/adminobject/edititem/6650>

### Sputter Rate List

Name	TI	Access	Description	Actions
_Template	-1	Public	Template for sputter rate (this is not sputter rate for Hydrogen)	 
All Sputter Rates (for test)	0	Public	All Sputter Rates (for test)	 

3) Create a new object and in UI **press “Download properties in Excel” button**: <https://demo.mdi.ruhr-uni-bochum.de/object/all-sputter-rates-for-test-6651> to get template in Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q		
1	Material	Trust	Deposition Date	Chamber	LogbookId	Rate, nm/sec	Time, sec	Thickness, nm	Normalized Rate, nm/W*sec	Power, W	Power Supply	Cathode	Pressure, mTorr	Argon Flow, sccm	Working Distance	Cathode Tilt, mm	Working Distance	Table Height, mm	Comment
2	String	Int	String	Int	String	Float	Float	Float	Float	Float	String	Int	Float	Float	Float	Float	Float	String	

4) **Modify** template in Excel file **and upload** the data: <https://demo.mdi.ruhr-uni-bochum.de/object/all-sputter-rates-for-test-6651> (test passed: 16 columns and 468 rows)

# RDMS: Search

## Search on:

- 1) Chemical system
- 2) Composition
- 3) Object type
- 4) Phrase in object's Name or Description
- 5) Properties values (all available within tenant)
- 6) Person created
- 7) Creation date

## Important feature:

**persistent URL on search** (share search results easily by URL\*).

\* - respecting current security context

## Search

system As-Ga and As in [30%; 50%] and Ga in [1; 3] and E in [1.5; 2] and Comment contains 'solution'

Periodic table showing elements Ga and As highlighted in red boxes and circled in yellow. The search criteria are: system As-Ga and As in [30%; 50%] and Ga in [1; 3] and E in [1.5; 2] and Comment contains 'solution'.

Chosen elements: **As-Ga** [clear]

	Absolute		Percentage	
Ga	1	≤ N ≤	3	or min ≤ N % ≤ max
As	min	≤ N ≤	max	or 30 ≤ N % ≤ 50

### Additional filters

Object type:  Search phrase:

Property type:  Name:  Property Value:  ≤ value ≤

Property type:  Name:  Property Value:

Created by:  from:  till:

# RDMS DropZone Tasks: Data Validation & Import

**Task:** validate documents & import data

Area A / A04

A04

Add Subproject

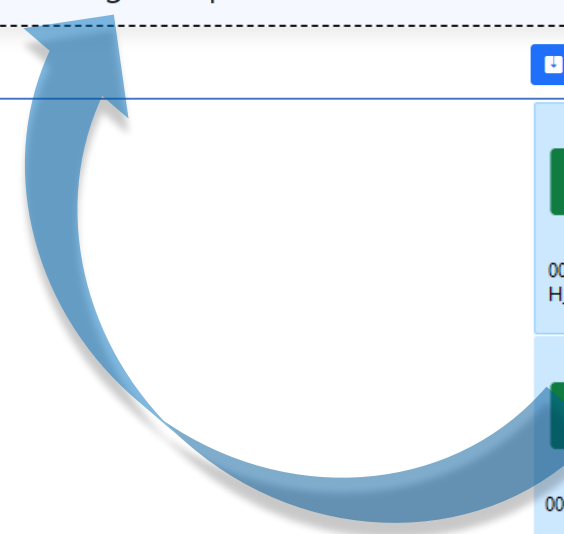
Upload Files (by creating objects)

Drag&Drop files here

Upload and Preview

## Implemented Features:

- Automatic type detection;
- Uniqueness check;
- Data **validation** (build-in + external);
- Data **import**.



0008081\_EDX\_ZG H\_Ho L default - Copy

0008081\_EDX\_ZG H\_Ho L default

0008081\_EDX1

0008081\_EDX2

0008081\_EDX3

0008081\_EDX4

0008081\_EDXmap ping

0008081\_HTTs\_4P P\_all

0008081\_HTTs\_4P P\_all

0008081\_HTTs\_4P P\_cut

0008081\_photo

0008081\_XRD\_bas eline subtracted\_10-9 8\_1e6-0.0007

0008081\_XRD\_bas eline subtracted\_10-9 8\_1e6-0.0007\_n...

0008088\_EDX\_ZG H\_Ho L default



# RDMS DropZone: Staged Files (before import)

INF(N)

## Objects to create

### Files to process

0008081_EDX1.png	Type: EDX Image	Name: 0008081_EDX1	Sort Code: 10
System.Exception column 6: dfg (unknown column name) 0008081_EDX_ZGH_Ho L default - Copy.csv	Type: EDX CSV	Name: 0008081_EDX_ZGH_Ho L default - Copy	Sort Code: 20
0008081_EDX_ZGH_Ho L default.csv	Type: EDX CSV	Name: 0008081_EDX_ZGH_Ho L default	Sort Code: 30
0008081_HTTPS_4PP_all.csv	Type: HTTPS CSV	Name: 0008081_HTTPS_4PP_all	Sort Code: 40
0008081_HTTPS_4PP_all.png	Type: HTTPS Image	Name: 0008081_HTTPS_4PP_all	Sort Code: 50
0008088_EDX_ZGH_Ho L default.csv	Type: EDX CSV	Name: 0008088_EDX_ZGH_Ho L default	Sort Code: 60

### Common properties:

Access Control (accessibility): public Rubric: \_A04

### Link as Associated Objects with:

Sample 8081 (V-Mn-Co-Ni-Ho).[Sample]

Search Sample objects: 8081 Search

Successful validation of all files required

Create Objects from Files

Check for unique documents (based on SHA256 hash):

### Files to process

0008081_EDX_ZGH_Ho L default.csv	Type: EDX CSV	Name: 0008081_EDX_ZGH_Ho L default	Sort Code: 10
----------------------------------	---------------	------------------------------------	---------------

Check data to import:

```
Data to be put in database
{
  "deletePreviousProperties": true,
  "properties": [
    {
      "type": 1,
      "name": "V",
      "value": 0,
      "valueEpsilon": null,
      "sortCode": 10,
      "row": 1,
      "comment": "Minimal V content"
    },
    {
      "type": 1,
      "name": "V",
      "value": 36.4,
      "valueEpsilon": null,
      "sortCode": 10,
      "row": 2,
      "comment": "Maximal V content"
    }
  ]
}
```

Properties (after import):

The table		Choose File	No file chosen	
V	Min	Co	Ni	Ho
0	0	0	0	20.8
36.4	16.1	46.5	19.1	100

## Workflow:

- validate every file;
- check/adjust all properties;
- Import files.

# RDMS: Created Objects



DIMENSION Database Search Tree Edit List Edit Hello vic.dudarev@gmail.com! Logout

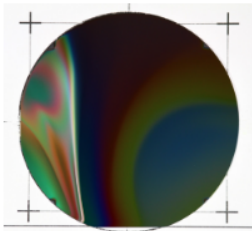
P1 / [Ho-V-Mn-Co-Ni-O](#) / [Ho50%](#) / [Sample 8081](#)

## Sample 8081

[Add Subproject](#)

[Sample 8081 Ho-V-Mn-Co-Ni-O](#) [Protected Sample](#)  
ID#0008081 | Ho-V-Mn-Co-Ni-O | Ho50% | TH25 | 550°C | 300 nm | EDX, XRD, HTTS | on Si wafer

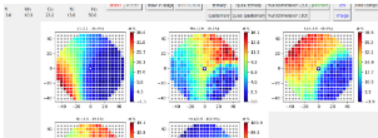
[Photo of Sample 8081](#) [Protected Photo](#)



[0008081\\_photo.JPG](#)

[EDX CSV for sample 8081](#) [Protected EDX CSV](#)  
ZGH  
[show table](#)  
[0008081\\_EDX\\_ZGH\\_Ho\\_L\\_default.csv](#)

[EDX Image for sample 8081 1](#) [Protected EDX Image](#)



## After import:

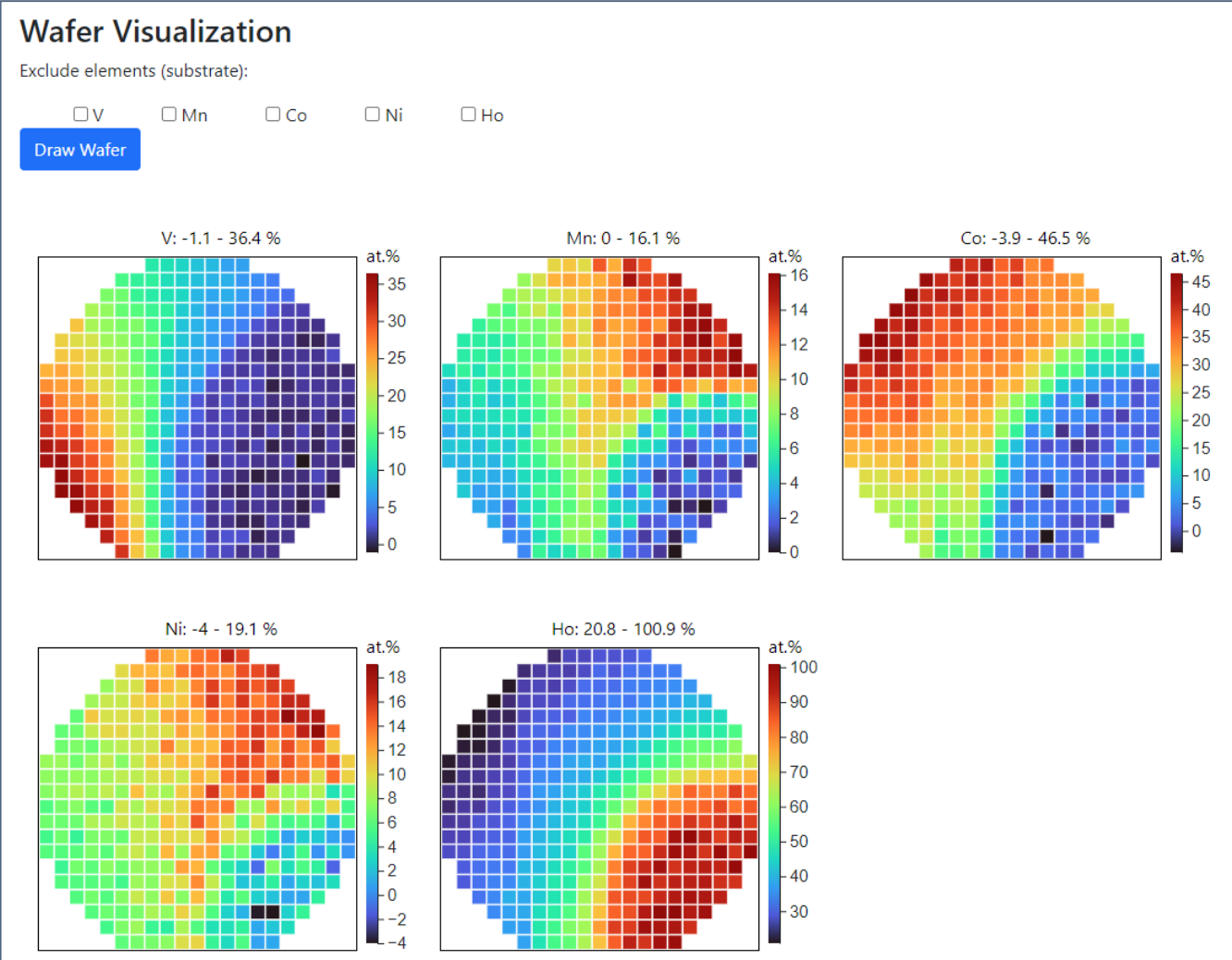
- check all created objects (names, access level, etc...);
- share a link.





# RDMS: CSV Visualization

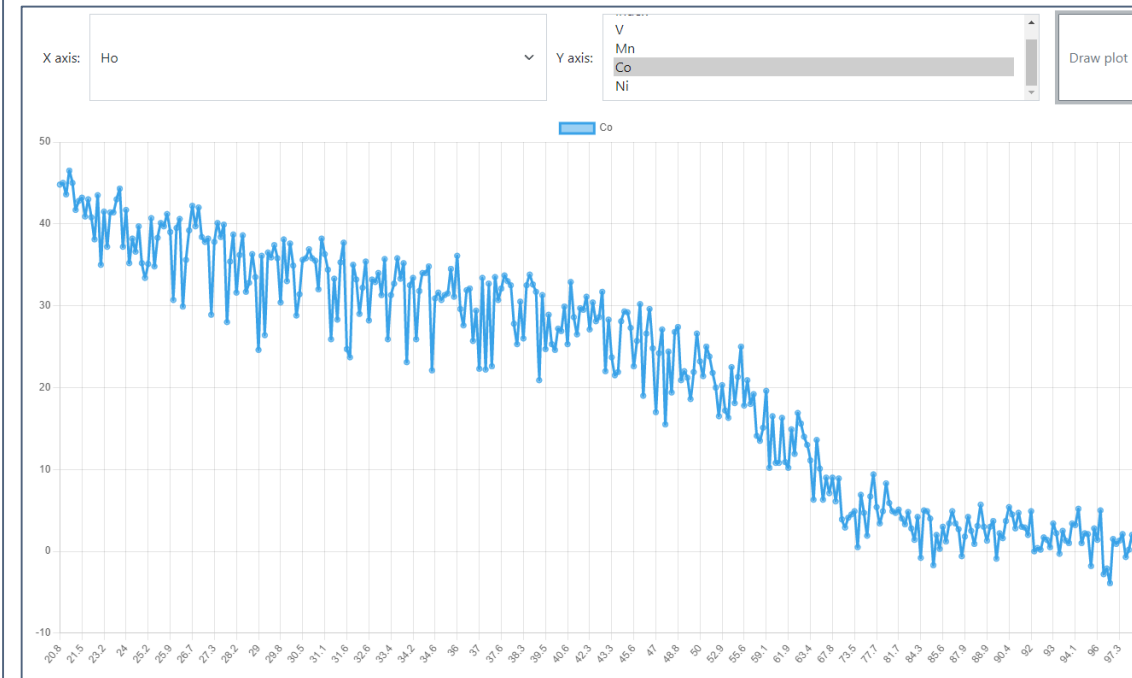
## Wafer Visualization



## CSV Viewer: EDX CSV for sample 8081

Index	V	Mn	Co	Ni	Ho
297	18.8	7.5	44.8	8	20.8
261	22.4	5.6	45	6.2	20.9
280	23.2	6	43.6	6.2	21.1
312	16.7	8	46.5	7.7	21.1
262	21.4	5.8	45	6.6	21.2
221	24.3	5	41.7	7.8	21.3
243	22.9	5.9	42.8	7	21.4
242	23	5.7	43.2	6.6	21.5

## Configurable XY-charts



# RDMS Extensibility: Additional Object Types

**Task:** introduce new object types

## New Data Type

Based on existing tables

(hierarchical and non-hierarchical)



**To be done manually by admin**

Approximate time: 3 minutes

Just add a new table row with object specification required (assign validator & data extractor)

Add new type to TypeInfo table

TypeId	IsHierarchical	TypeIdForRubric	TypeName	TableName
1	True	NULL	Organisation Structure	RubricInfo
2	True	NULL	Project	RubricInfo
3	False	2	Literature Reference	Reference
4	False	2	Publication	Reference
5	False	2	Substrate	ObjectInfo
6	False	2	Sample	Sample
7	False	2	Raw Document	ObjectInfo
8	False	2	Composition	Composition
9	False	2	Tag	ObjectInfo
10	False	2	System	Sample

New Data Structures

(new table & code to fit particular requirements)



**To be done manually**

Approximate time: 1 week

**Tasks:** develop and add new table; define read / write logic with respect to mandatory (or optional) fields and types; reflect to OOP model and provide consistency check (validators); develop import / export and search facilities, etc.

**Question:** It seems that all can be done with extended properties.

Why to use new data structures?









**Short Answer:** **Performance** (especially if number of new type objects is expected to exceed 10K)

# RDMS Extensibility: Type Configuration and Flexibility

**Task:** introduce new types and configure them (validation and data import)

## All types

For Hierarchical data types Table must be RubricInfo

Id	Name	Table	Description	Validation Schema / Data Schema	Actions
8	Composition	Composition	Composition information (compound)	type:TypeValidationLibrary.TypeValidator_Ok /	 
13	EDX CSV	ObjectInfo	CSV of EDX with Header row (e.g. "Index,V,Mn,Co,Ni,Ho")	type:TypeValidationLibrary.TypeValidator_EDX_CSV / type:TypeValidationLibrary.TypeValidator_EDX_CSV	 
15	EDX Image	ObjectInfo	Image (bitmap) that refers to EDX	type:TypeValidationLibrary.TypeValidator_	 
14	HTTS CSV	ObjectInfo	CSV of HTTS with Header row (e.g. "Index,Resistance")	type:TypeValidationLibrary.TypeValidator_	 

Responses

Code	Description	Links
200	Success	No links

Media type

Controls Accept header.

Example Value | Schema

```
{  
  "code": 0,  
  "message": "string",  
  "warning": "string"  
}
```

### Editing type EDX CSV

TypeId: 13

Type Name:

Table Name (Data Structure):

Hierarchical classifier:

Validation Schema:

Data Schema:

Description:

Data to be put in database

```
{  
  "name": "EDX",  
  "table": "ObjectInfo",  
  "validation": "type:TypeValidationLibrary.TypeValidator_EDX_CSV",  
  "data": "type:TypeValidationLibrary.TypeValidator_EDX_CSV",  
  "description": "CSV of EDX with Header row (e.g. \"Index,V,Mn,Co,Ni,Ho\")",  
  "parent": "Project",  
  "code": 13,  
  "comment": "EDX CSV content"  
}
```

## Validation & Data Schema Protocols:

- **type:** built-in type (object instantiated by class name);
- **https:** URL to a REST Web Service (OpenAPI specification).

```
66 references  
public class TypeValidatorResult  
{  
  12 references  
  public int Code { get; set; }  
  11 references  
  public string? Message { get; set; }  
  7 references  
  public string? Warning { get; set; }  
}
```

# RDMS Demonstration: Bandgap Data

**Task:** check RDMS on Bandgap data from [bg.imet-db.ru](https://bg.imet-db.ru) to test functionality and features.

## Source data in numbers:

- Substances: 4748
- Bandgap records: 10264
- Literature references: 1861

## Projects structure:

Bandgap measurement -	Elements
Literature References	Binary Compounds
	Ternary Compounds
	Quaternary Compounds
	Multi-Component Compounds

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DEMO Database Search Tree Edit List Edit Hello vic.dudarev@gmail.com!

### List Editor

## Objects in RDMS

Select list type to edit:

- **Literature Reference**<sup>1861</sup> Reference [Information about publications that are considered useful within a project or to which you are referecing in publications]
- **Publication**<sup>0</sup> Reference [Publication (published or is going to be published material accouring to current work)]
- **Substrate**<sup>0</sup> ObjectInfo [Wafer material]
- **Sample**<sup>0</sup> Sample [Sample information (sputter deposition)]
- **Raw Document**<sup>0</sup> ObjectInfo [Data file on disk in any format (file extension required to identify MIME-type)]
- **Composition**<sup>4748</sup> Composition [Composition information (compound)]
- **Tag**<sup>0</sup> ObjectInfo [Tags for assigning to objects]
- **System**<sup>0</sup> Sample [Chemical system]

Bandgap values (~10K) are stored in extended properties tables:

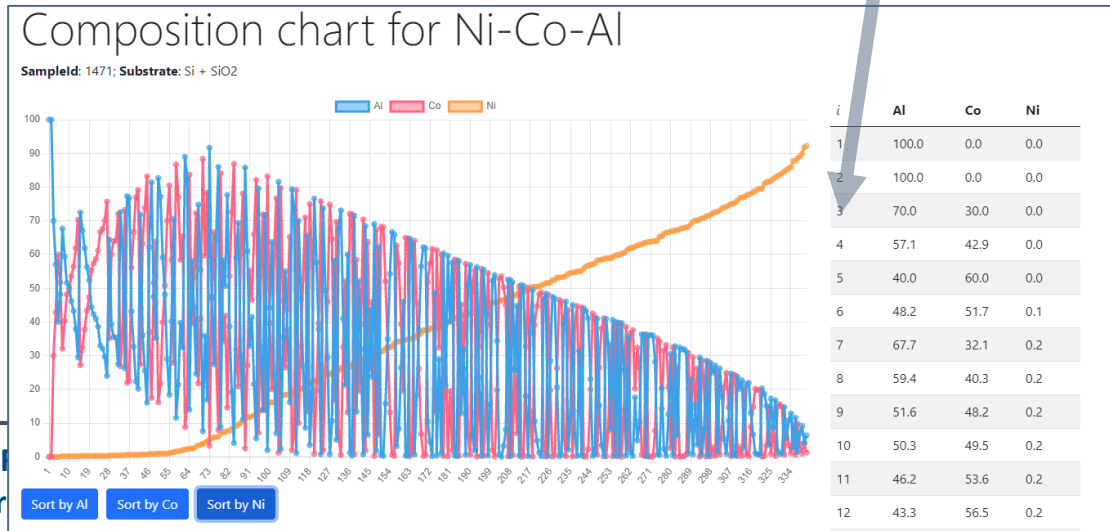
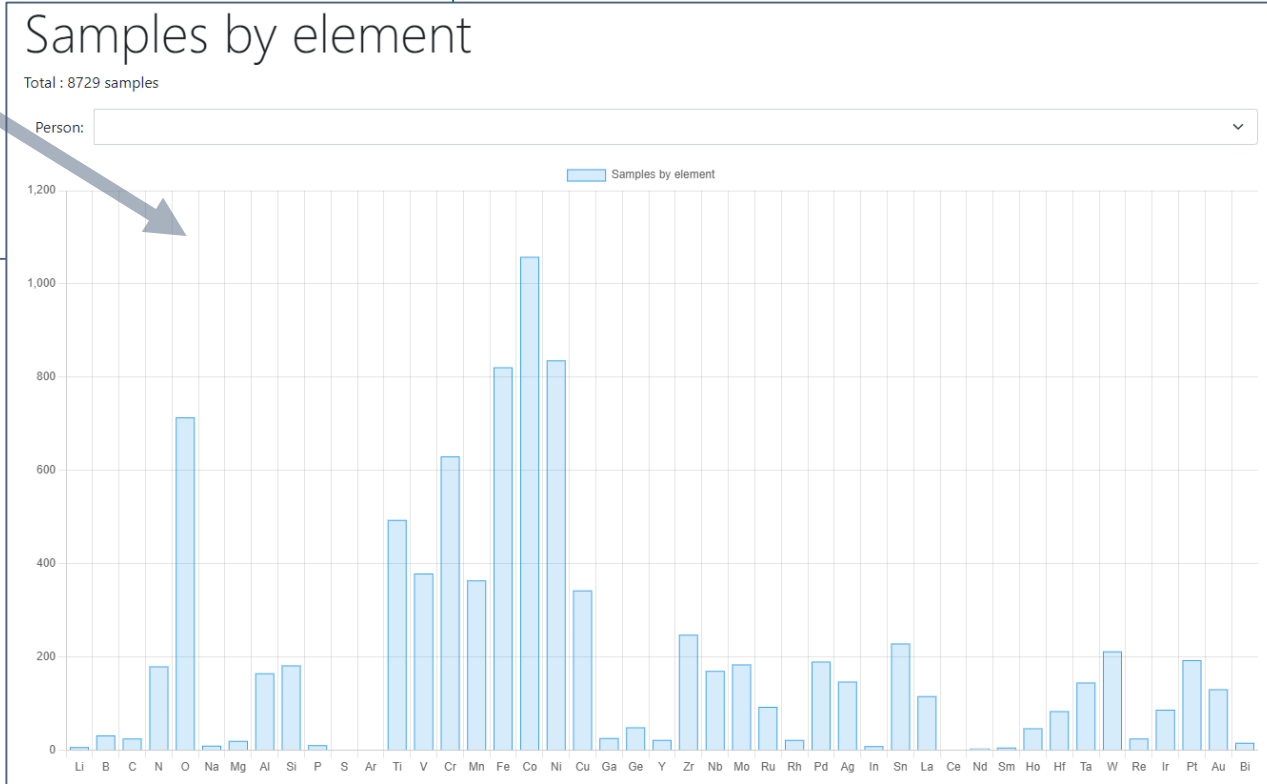
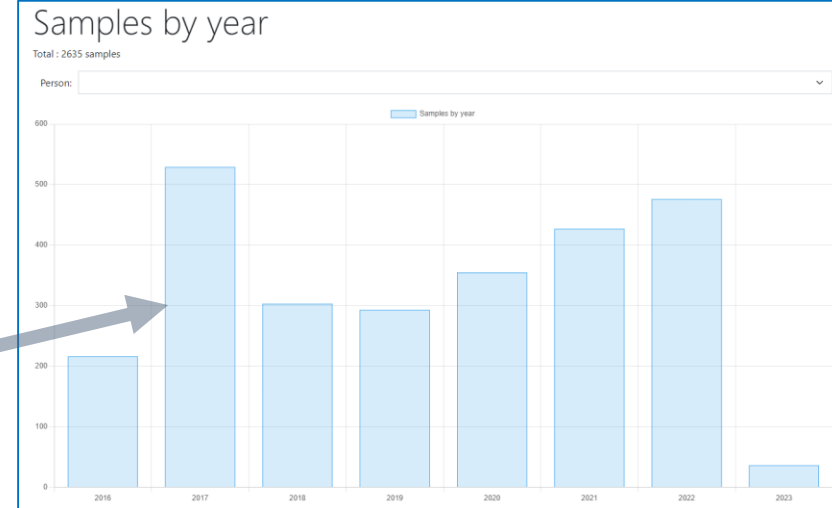
- BigString: 0 records
- String: **28992** records
- Int: **20527** records
- Float: **15149** records

**Total: 71 277** records in demo tenant for bandgap data.

# RDMS: the Next Steps

## Tasks (to be done):

- refine UI for PowerUsers, incorporated in regular (end-user) interface + UI w.r.t. data types
- **API to upload data from measurement devices (Bandgap, Resistance)**
- Implement Reports / Charts / Diagrams on stored data in various aspects (like in WebCompact)
- Existing object types Bulk Import from CSV files (with CSV-schema validation) and Export



# Source Control (GitLab)

Everybody's welcome!

Core INF project:

<https://gitlab.ruhr-uni-bochum.de/vic/infproject>

Web Compact:

<https://gitlab.ruhr-uni-bochum.de/vic/WebCompact>

Shared projects (INF & WebCompact):

1) Administration User Interface (Identity Manager UI):

<https://gitlab.ruhr-uni-bochum.de/vic/identitymanagerui>

2) Web Application General Library (WebUtilsLib):

<https://gitlab.ruhr-uni-bochum.de/vic/webutilslib>

<https://gitlab.ruhr-uni-bochum.de>

The screenshot shows the GitLab web interface for the 'InfProject' repository. The left sidebar contains navigation options: Project Information, Repository, Issues (0), Merge requests (0), CI/CD, Security & Compliance, Deployments, Packages and registries, Infrastructure, Monitor, Analytics, Wiki, Snippets, and Settings. The main content area displays the repository name 'InfProject' with a shield icon, Project ID 1673, and statistics: 7 Commits, 1 Branch, 0 Tags, and 7.4 MB Project Storage. A description states: 'Multitenant Research Data Management System in chemistry domains. Built and maintained as a part of INF project within SFB CRC247. Runs at <https://demo.mdi.ruhr-uni-bochum.de/>'. Below this is a search bar with the text 'Search Done' and 'Victor Dudarev authored 58 minutes ago'. A file browser shows the current branch 'master' and a list of files: 'InfProject', '.gitignore', 'InfProject.sln', and 'global.json'. The 'InfProject' file is selected, showing its commit history in a table.

Name	Last commit	Last update
InfProject	Search Done	58 minutes ago
.gitignore	InitialCommit (tree editing ready)	2 months ago
InfProject.sln	InitialCommit (tree editing ready)	2 months ago
global.json	InitialCommit (tree editing ready)	2 months ago

The screenshot shows the Git Extensions desktop application interface. The top menu bar includes Start, Repository, Navigate, View, Commands, GitHub, Plugins, Tools, and Help. The main window displays the commit history for the 'InfProject' repository on the 'master' branch. The commit list is as follows:

Commit	Author	Date	Hash
849afc7	Victor Dudarev	1 day ago	849afc7
83cbdfc	Victor Dudarev	15 days ago	83cbdfc
5eea0a7	Victor Dudarev	25 days ago	5eea0a7
787fa0c	Victor Dudarev	1 month ago	787fa0c
c57dacf	Victor Dudarev	2 months ago	c57dacf
7075154	Victor Dudarev	2 months ago	7075154
db276bb	Victor Dudarev	2 months ago	db276bb

The bottom of the window shows the commit details for the selected commit (849afc7):

Author: [Victor Dudarev <vic.dudarev@gmail.com>](mailto:vic.dudarev@gmail.com)  
Date: 1 day ago (10.02.2023 18:53:53)  
Commit hash: 849afc7d8d22354c3c492121bbb8143501771450  
Child: [Commit index](#)  
Parent: [83cbdfc](#)



# RDMS Playground



<https://demo.mdi.ruhr-uni-bochum.de/>



<https://inf.mdi.ruhr-uni-bochum.de/>

Playground to test RDMS (multiple tenants with shared users list):

<https://demo.mdi.ruhr-uni-bochum.de/>

<https://inf.mdi.ruhr-uni-bochum.de/>

Login and Password (**User** role): User1@user.org

Login and Password (**PowerUser** role): PowerUser1@user.org

Login and Password (**Administrator** role): Admin1@user.org

Thanks for your kind attention

INF(N)

# Demonstration

## Q&A



You are welcome to write your questions (and I'll answer) and provide feedback:

<https://shorturl.at/ikNST>

Victor Dudarev

[Victor.Dudarev@rub.de](mailto:Victor.Dudarev@rub.de)



FAIR Principles for scientific data management

## 1) Findable

First step in (re)using data: Find them (humans and computers)

- F1. (Meta) data are assigned a **globally unique and persistent identifier** → **URI**
- F2. Data are described with **rich metadata** (as defined by R1 below) → **JSON Schema**
- F3. Metadata clearly and explicitly include the identifier of the data they describe → **... of course**
- F4. (Meta)data are registered or indexed in a searchable resource  
→ **schemastore.org/json**

FAIR Principles for scientific data management

## 2) Accessible

Once the user finds the required data, they need to know how they can be accessed, possibly including authentication and authorization.

- A1. (Meta)data are retrievable by their identifier using a standardized communications protocol

- A1.1 The protocol is open, free, and universally implementable



**HTTPS, Open  
API**

- A1.2 The protocol allows for an authentication and authorization procedure, where necessary



**OAuth + OpenID Connect**

- A2. Metadata are accessible, even when the data are no longer available



**keep it in mind... Metadata are never deleted!**

FAIR Principles for scientific data management

## 3) Interoperable

The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

- I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.

 **OWL**





- I2. (Meta)data use vocabularies that follow FAIR principles  **reference**

- I3. (Meta)data include qualified references to other (meta)data  **URI**

FAIR Principles for scientific data management

## 4) Reusable

The ultimate goal of FAIR is to optimize the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings.

- R1. (Meta)data are richly described with a plurality of accurate and relevant attributes  **JSON Schema**
- R1.1. (Meta)data are released with a clear and accessible data usage license  **GPL**
- R1.2. (Meta)data are associated with detailed provenance  **reference source by URI**
- R1.3. (Meta)data meet domain-relevant community standards  **JSON Schema Validator + Git Flow**

## Runs under .NET 7

WebCompact Search All Samples Tree Register Login

### Log in

Use a local account to log in. Use another service to log in.

Google

Email: dudark9

Password: .....

Remember me?

Log in

[Forgot your password?](#)

[Register as a new user](#)

[Resend email confirmation](#)

© 2022 - WebCompact - [Privacy](#), [Terms of Service](#)

WebCompact Search All Samples Tree Reports Hello vic.dudarev@gmail.com! Logout

## WebCompact

### Hello, vic.dudarev@gmail.com!

You are successfully authenticated...

You are in the following roles:

- **User** (Read-only access to WebCompact)
- **PowerUser** (Read-write access to WebCompact (to be implemented))
- **Administrator** (User access control list)



WebCompact Search All Samples Tree Reports Hello vic.dudarev@gmail.com! Logout

## Samples

Chosen elements: empty

Additional filters

Substrates: FTO Sapphire ITO Fused Silica Si Si + SiO2 ionic liquid Alumina other

Project Name: [input]

Person: [dropdown] Chamber: [dropdown]

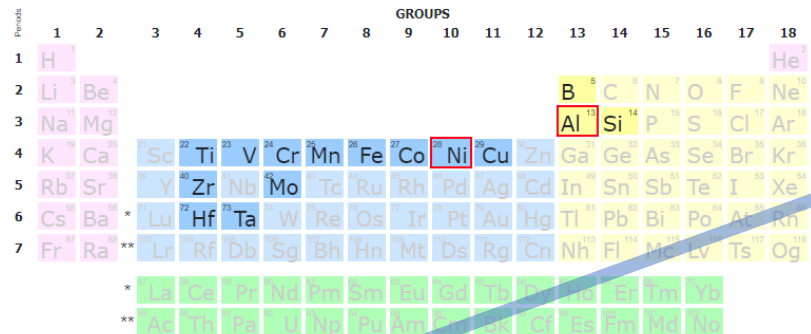
Created from: mm/dd/yyyy till: mm/dd/yyyy [calendar icon] Search

Please select some substrates or elements...

# WebCompact Search



## Samples system Al-Ni



Chosen elements: **Al-Ni** [\[clear\]](#)

Additional filters

Table (14) List (14)

Id	Created	Project Name	Person	N	Sample Material
<a href="#">1471</a>	2016-11-02	Ni-Co-Al based materials	Decker Peer	3	Al-Co-Ni (Ni-Co-Al)
<a href="#">1124</a>	2016-04-20	Fachlabor (Dennis N.)		2	Al-Ni (Ni-Al)
<a href="#">1261</a>	2016-07-14	Fe-based SMAs	Decker Peer	4	Al-Fe-Mn-Ni (Fe-Ni-Mn-Al)

## Sample Project Ni-Co-Al based materials

### Sample Information

Name	Value
<b>Project Data</b>	
Project Name	Ni-Co-Al based materials
Sample Name	Ni-Co-Al full ternary - Ni-Co-Al
Sample Description	Ni-Co-Al full ternary
Sample Material	Ni-Co-Al
Composition Description	ternary
Substrate Material	Si + SiO2
Project Comment	141128_K1-2

### Sample Documents

Document Id	Processing State	Characterization	CadRefFileName	Data
9522	Raw Data	chem. composition	141128K1-2_annealed.txt	<a href="#">000008958_00.00_9522.txt</a> <a href="#">process &amp; show compositions</a>
9523	Raw Data	chem. composition	141128-K1-2_annealed_standard.txt	<a href="#">000008959_00.00_9523.txt</a> <a href="#">process &amp; show compositions</a>

9519	Processed Data	photo	141128-K1-2_bearbeitet.tif	<a href="#">000008955_00.00_9519.tif</a>	
9520	Processed Data	photo	141128-K1-2_mit Nummern.doc	<a href="#">000008956_00.00_9520.doc</a>	
9521	Raw Data	photo	IMG_8731.JPG	<a href="#">000008957_00.00_9521.JPG</a>	
9536	Raw Data	synchrotron	141128-K1-2_Synchrotron_raw_data.zip	<a href="#">000008972_00.00_9536.zip</a>	
9537	Processed Data	synchrotron	141128-K1-2_Peak fits_Synchrotron.zip	<a href="#">000008973_00.00_9537.zip</a>	
9547	Processed Data	synchrotron	141128-K1-2_Synch.txt	<a href="#">000008979_00.00_9547.txt</a>	
9548	Processed Data	XRD	141128-K1-2_XRD.txt	<a href="#">000008980_00.00_9548.txt</a>	
9549	Processed Data	XRD	141128-K1-2_XRD_reduced.txt	<a href="#">000008981_00.00_9549.txt</a>	
9550	Raw Data	XRD	141128-K1-2_XRD.opj	<a href="#">000008982_00.00_9550.opj</a>	
9552	Raw Data	XRD	141128-K1-2_XRD_raw.zip	<a href="#">000008983_00.00_9552.zip</a>	

Processed Data	chem. composition	141128-K1-2_Al-Ni_EDX_standard_correct.opj	<a href="#">000008960_00.00_9524.opj</a>	
Processed Data	chem. composition	141128-K1-2_EDX_Al-Differenz.tif	<a href="#">000008961_00.00_9525.tif</a>	
Processed Data	chem. composition	141128-K1-2_EDX_Vergleich.tif	<a href="#">000008962_00.00_9526.tif</a>	
Processed Data	chem. composition	141128-K1-2_EDX_Vergleich_mit Standard.tif	<a href="#">000008963_00.00_9527.tif</a>	

# WebCompact: Sputter Rates



- **List of digitalized sputter rates**  
(User group access)
- **Download (export) data**  
(Administrator group or user with `_SputterRate.read` claim)
- **Upload (import) data**  
(Administrator group or user with `_SputterRate.write` claim)
- **Person in charge:**  
Alan Savan

compact Search All Samples Tree Reports Search Rates All Rates Hello vic.dudarev@gmail.com

## All Sputter Rates

Table (468) List (468)

Download rates in Excel Choose File No file chosen Upload / update rates from Excel

Material	Trust	LogbookId	Rate, nm/sec	Normalized Rate, nm/W*sec	Time, sec	Thickness, nm	Cathode	Power, W	Power Supply	Comment
Ag	1	<a href="#">061228-K1-3</a>	0.09506	0.000951	1800	171.1	6	100	RF	Book 3: April 2006-Jan 2007
Ag	0	<a href="#">061229-K1-1</a>	0.34848	0.001742	1800	627.27	6	200	RF	Book 3: April 2006-Jan 2007
Al	0	<a href="#">080319-K1-1</a>	0.145	0.000725	1800	261	6	200	RF	
Al	0	<a href="#">080424-K1-2</a>	0.056	0.000373	2700	151.2	5	150	RF	
Al	0	<a href="#">080516-K1-3</a>	0.02107	0.000351	2700	56.9	5	60	RF	Book 6: March 2008-April 2009
Al	0	<a href="#">080519-K1-2</a>	0.01421	0.000237	12000	170.5	5	60	RF	Book 6: March 2008-April 2009
Al	0	<a href="#">080529-K1-1</a>	0.04711	0.000337	5400	254.4	5	140	RF	Book 6: March 2008-April 2009
Al	0	<a href="#">100228-K1-1</a>	0.058	0.000387	2700	156.6	5	150	RF	

Hints: LogbookId – primary key;

Trust = -1000 – delete record on upload.

# WebCompact: Search for Sputter Rates

Search on (+ sort results):

- Elements
- Cathode
- Chambers
- LogbookId (Date-Chamber-N)
- Rate range
- Power range

Sputter Rates

Chosen elements: Si [clear]

Chambers: K1 K2 K3

Logbook Id: Logbook Id, e.g. 061228-K1-3

Cathode: [dropdown]

Normalized Rate (nm/W\*Sec) from: minimum value, e.g. 9E-06 till: maximum value, e.g. 0.0074

Power (W) from: minimum value, e.g. 14 till: maximum value, e.g. 600 [Search]

Material	Trust	LogbookId	Rate, nm/sec	Normalized Rate, nm/W*sec	Time, sec	Thickness, nm	Cathode	Power, W	Power Supply	Comment
Si	1	<a href="#">160307-K1-1</a>	0.07315	0.001463	2500	182.88	3	50	pDC	
Si	1	<a href="#">061117-K2-1</a>	0.013	0.000126	900	11.3	4	100	RF	
Si	0	<a href="#">061120-K2-1</a>	0.029	0.000145	1800	52.3	4	200	RF	

It provides a good “starting point” to suggest sputtering mode settings and time to achieve desired thickness.



# Detailed Information

Id  
Material  
Trust  
Deposition Date  
Chamber, №  
Logbook Id  
Rate, nm/sec  
Normalized Rate, nm/W\*sec  
Time, sec  
Thickness, nm  
Power, W  
Power Supply  
Cathode  
Pressure, mTorr  
Ar-Flow, sccm  
Cathode Tilt, mm  
Table Height, mm  
Comment

## Sputter Rate for W (111118-K3-4)

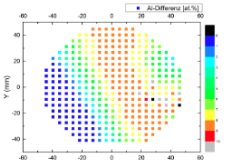


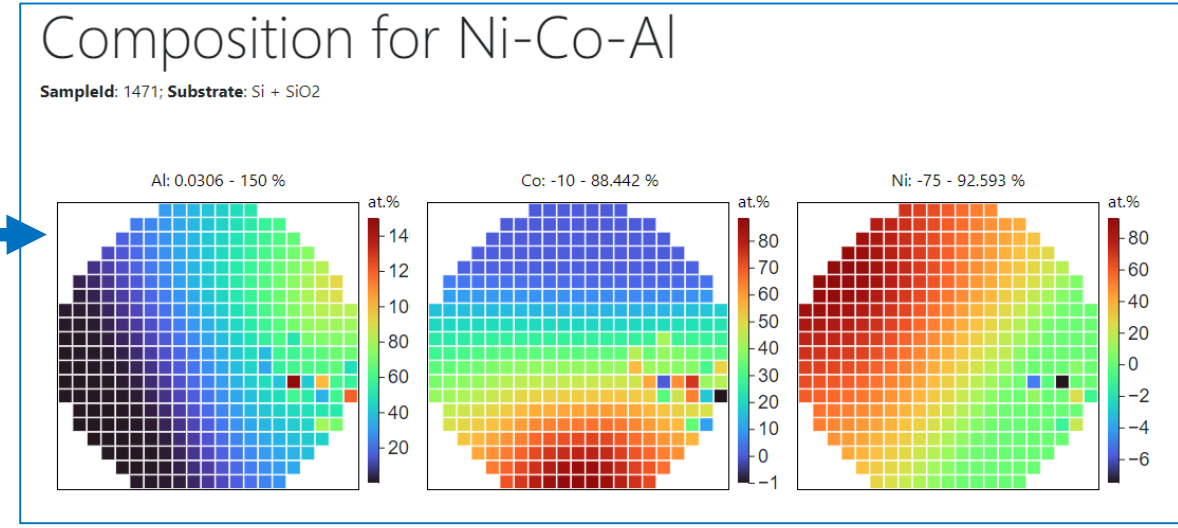
Name	Value
<b>Metadata</b>	
Id	506
Material	W
Trust	0
DepositionDate	2011-11-18
Chamber, №	3
Logbook Id	111118-K3-4
<b>Rate</b>	
Rate, nm/sec	0.245 nm/sec
Normalized Rate, nm/W*sec	0.00098 nm/W*sec
<b>Sputtering Parameters</b>	
Time, sec	
Thickness, nm	441.5 nm
Power, W	250 W
Power Supply	DC
Cathode	2
Pressure, mTorr	10 mTorr
Ar-Flow, sccm	40 sccm
<b>Working Distance</b>	
Cathode Tilt, mm	7.5 mm



# WebCompact and Data Visualization

Data processing with external software (written in Python) + visualization

Document Id	Processing State	Characterization	CadRefFileName	Data
9522	Raw Data	chem. composition	141128K1-2_annealed.txt	<a href="#">000008958_00_00_9522.txt</a> <a href="#">process &amp; show compositions</a>
9523	Raw Data	chem. composition	141128-K1-2_annealed_standard.txt	<a href="#">000008959_00_00_9523.txt</a> <a href="#">process &amp; show compositions</a>
9524	Processed Data	chem. composition	141128-K1-2_Co-Al-Ni_EDX_standard_correct.opj	<a href="#">000008960_00_00_9524.opj</a>
9525	Processed Data	chem. composition	141128-K1-2_EDX_Al-Differenz.tif	<a href="#">000008961_00_00_9525.tif</a> 



## Simple composition visualization (Chart.js)

9545	Processed Data	chem. composition	141128-K1-2_EDX.txt	<a href="#">000008977_00_00_9545.txt</a> <a href="#">show chart</a>
9546	Processed Data	chem. composition	141128-K1-2_EDX_Clustering_Standard.txt	<a href="#">000008978_00_00_9546.txt</a> <a href="#">show chart</a>
9529	Processed Data	el. resistance	141128-K1-1_R_neu.opj	<a href="#">000008965_00_00_9529.opj</a>
9530	Processed Data	el. resistance	141128-K1-1_R_neu_ausreißer korrigiert.opj	<a href="#">000008966_00_00_9530.opj</a>
9531	Processed Data	el. resistance	141128-K1-2_R_neu.jpg	<a href="#">000008967_00_00_9531.jpg</a> 