Semantically aided Material Selection Based on the Ontology of CroLOD framework

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System description and architecture

System architecture is basically divided into three layers. First there is web based frontend that can be accessed via desktop or mobile web browsers. Modern Web 2.0 implementations allow smooth user experience and enables engineers to easily find materials. After search query is submitted via web interface, backend of the system creates SPARQL queries and looks up in Virtuoso based storage. SPARQL is standard language for linked data queries. It allows system to search data based on partial or complete match of RDF triplets in database.
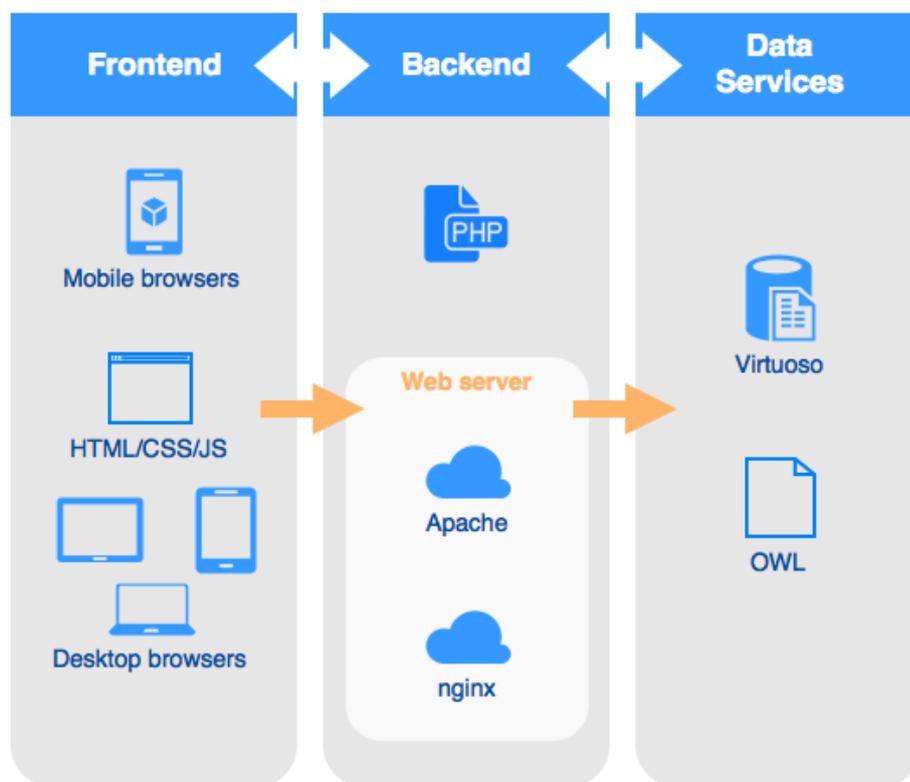
CroLOD system architecture

Ontology model of materials and their properties is built in Protégé tool. It consist of two parts (owl files) for easier appending and better organization. First part contains material types and properties and

second contains individuals. Material types are defined using *owl:Class* resource, while material properties are defined using *owl:DatatypeProperty* and *owl:ObjectProperty* relations.
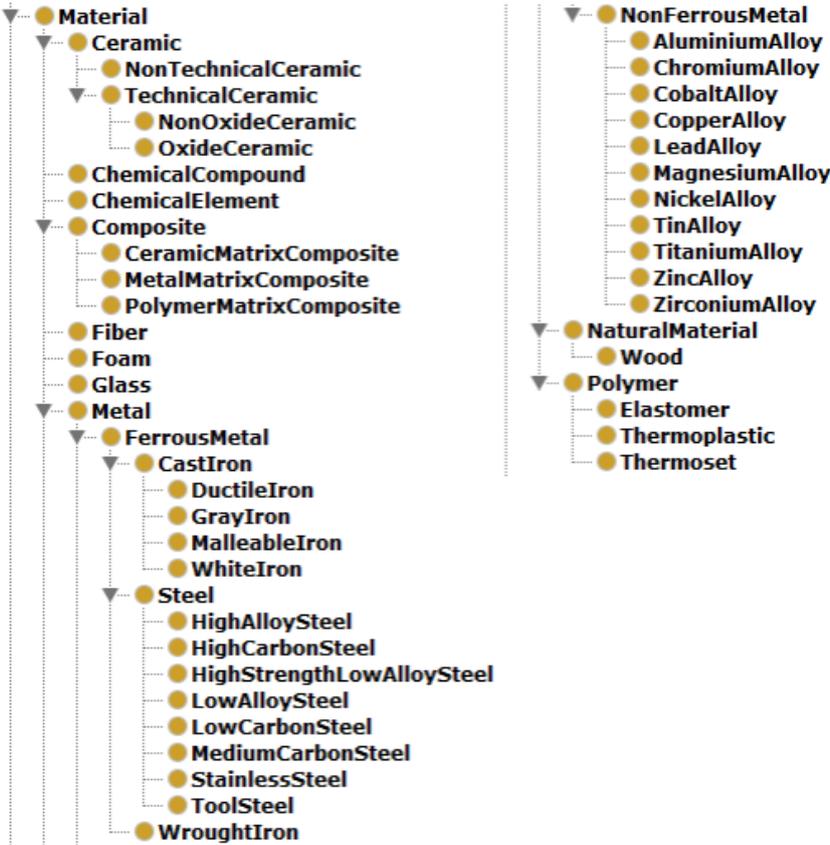

Figure 1

Under main class *owl:Thing* of OWL model, there is class *res:Material* which contains all other material subclasses. It represents main division of materials on ceramic materials, composites, fibers, foam, glass, metals and natural. It is possible to extend these classes in future. Beside material type classes there are also measurement unit classes like shown on Figure 2.
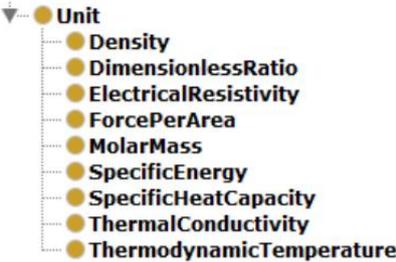

Figure 2

Additionally other ontologies like *owl:AnnotationProperty, owl:DatatypeProperty, owl:ObjectProperty*, etc. are developed.

System is developed on open source technologies and is capable of running either on Windows or

Linux based hosts. It requires web server (Apache or nginx) to be installed, as well as PHP5 support and Virtuoso database engine for storing ontologies.

Web application showcase and usage

Search form on main page is shown on Figure 3. It consists of several search options like simple search of materials, material types and properties and three buttons: Material properties, Material groups and Individual materials which enables users to limit search results on specific categories to achieve better search results.
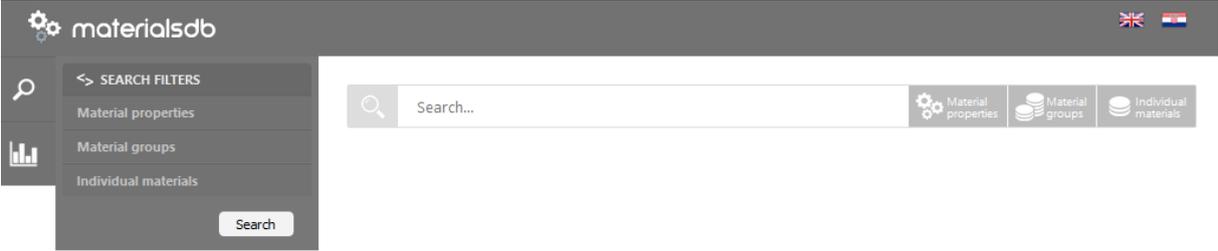
Figure 3

While user is typing its search query in the search field, autocompleter offers search results that consists of searched term, as shown on Figure 4.
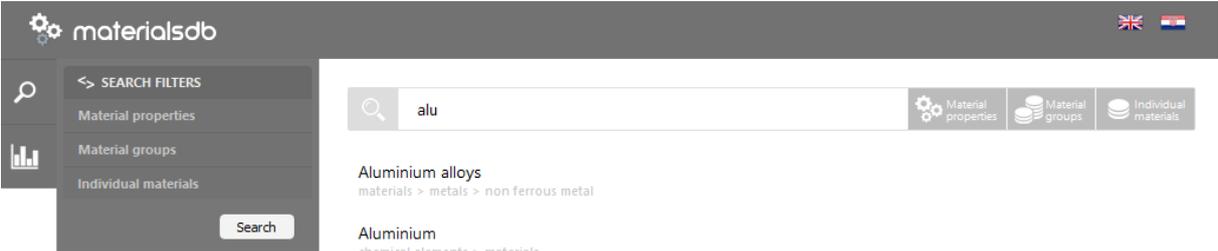
Figure 4

Additional material properties can be shown clicking on each search result (Figure 5)

Figure 5

In these results, minimal and maximal value of each property are only displayed for existing materials in database and not as general value. Bellow title, URI of material and additional info is shown with visual representation of tensile strength of each group. At the bottom of each group, there is slider bar which enables user to select minimal and maximal value that will be searched in database. Selected property is possible to add to the search filters. After adding it is possible to see which filters are active on the filter box show in Figure 6.

Figure 6

Previously added filter can be easily removed by clicking the X button.

Searching material groups is done in the same way, but in this case will be shown on properties that particular group has along with their details. By adding group materials into searching filters, search is limited to these groups only.
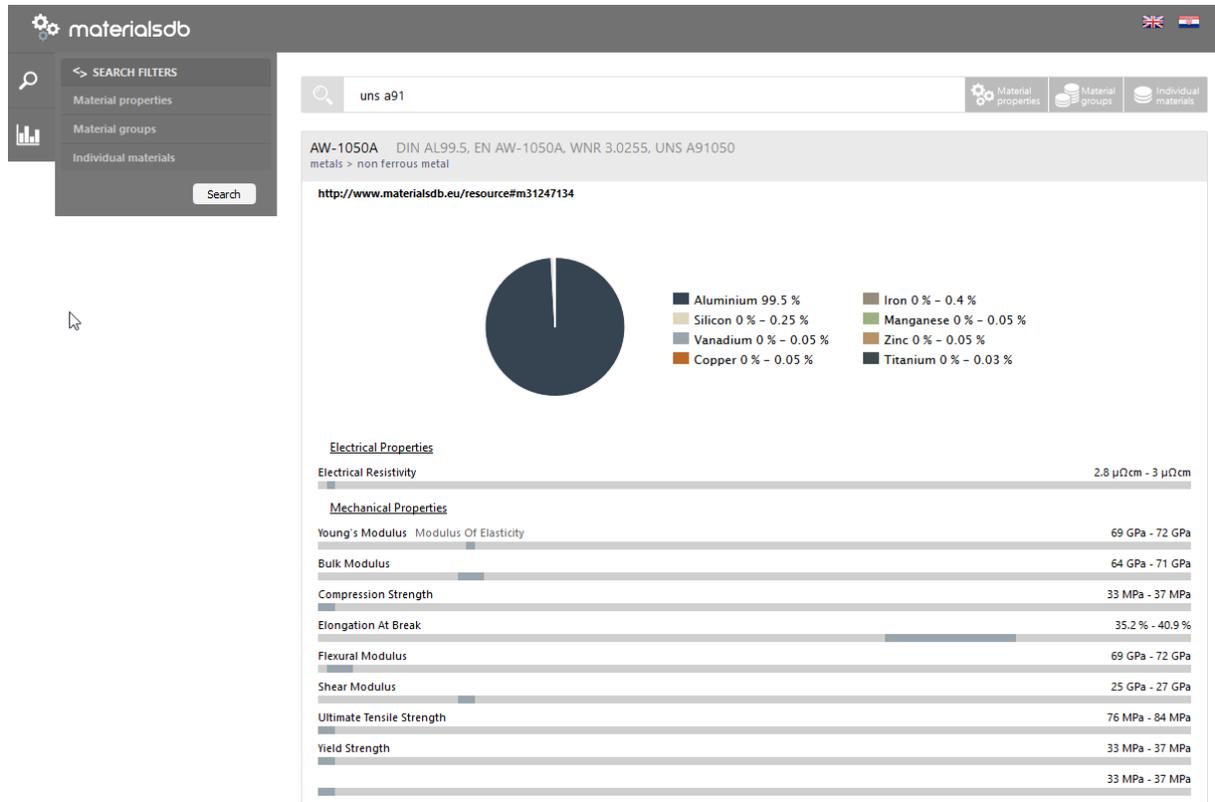

Figure 7

Figure 7 shows search results of individual materials including additional information about material (in this case aluminium alloy AW-1050A). Since aluminium presence is too high in this material, other elements aren't shown. It is possible to click on each element to hide it from the graph so other elements can pop out (Figure 8)
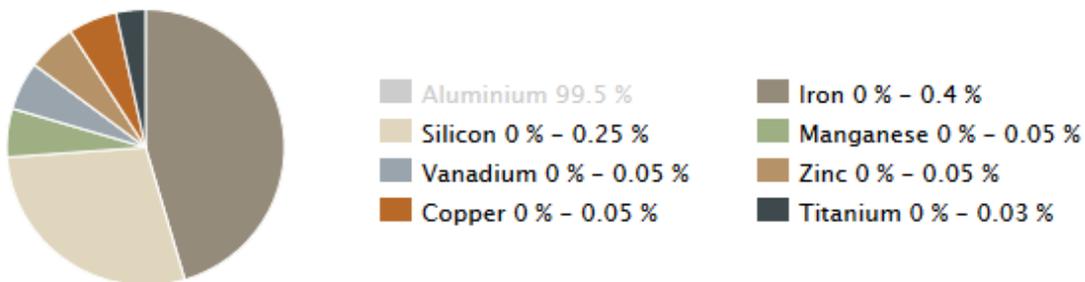

Figure 8

By combining these actions it's possible to add various properties, search material groups and add individual materials which we want to see.

For instance, if we want to find alloys which can hold working temperature of at least 400K and have tensile strength greater than 130 MPa, we can accomplish it like Figure 9 shows.
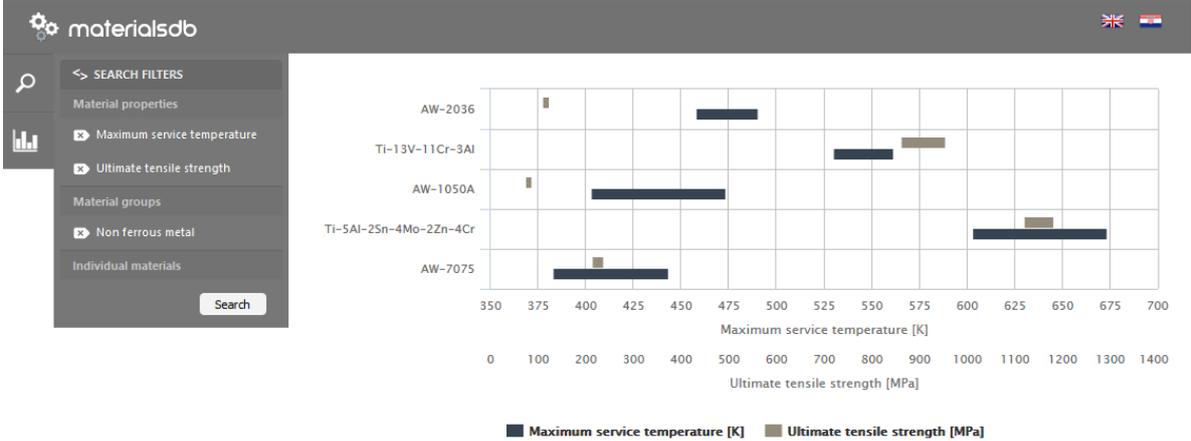

Figure 9

In this diagram, Y-axis shows list of materials which matches specified criteria. X-axis is defined as many time as material properties are defined. Each property can be shown or hidden in this diagram by simply clicking on its name to achieve better visibility of results. Hovering mouse cursor over each interval on this display results in popup window with detailed info like shown in Figure 10.
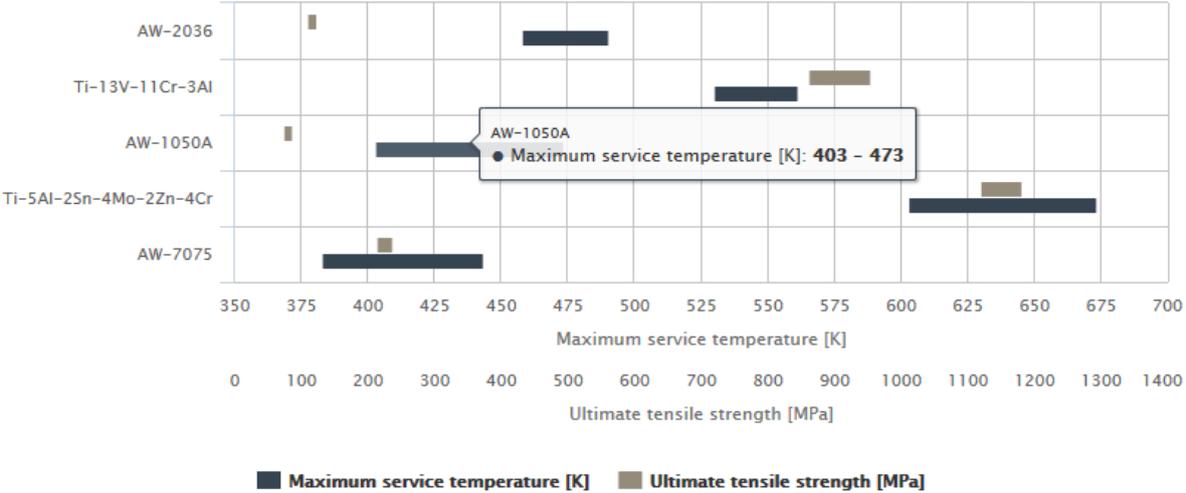

Figure 10

Materials which pops out in search results have to match all properties that are defined in search query. In case when material doesn't have some of properties filled in the database will still be considered as a

result. In that way we are able to display and these materials which doesn't have completely filled properties in database.