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TARGISOL: An ISOL-database on the web

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Abstract. An essential requisite for an efficient production of short-lived nuclei in an Isotope Separation On-Line (ISOL) facility is the fast release and extraction of the radioactive isotopes. In order to control the variables affecting the design and development of the target matrices and ion-sources, a database management system, called DifEfIsol, containing the relevant information of this diffusion-effusion process has been built. The Oracle database is constructed within an Open-URL framework directly reachable from any Web-browser at `http://www.targisol.csic.es`. The database includes the diffusion and desorption data of most elements in a range of materials. About 2400 entries are presently stored in the database. These data are used as input to a Monte Carlo simulation program that presently is being tested. This paper presents the database and the Web application as a tool for diffusion-effusion studies.

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1 Introduction

The production of radioactive isotopes is getting more difficult the further out from the line of stability the scientific interest is moving. Many elements, due to their specific chemical properties, are difficult to release from the production target in amounts sufficient for an experimental study. There are presently in the world several projects for the construction of the next generation Radioactive Nuclear Beam facilities. These new facilities will have higher primary beam energies and intensities in order to reach further away from stability and to increase the production yields. However, in order to be able to study more exotic (*i.e.* very short lived) isotopes one has to optimise not only the production but also the release of the produced isotopes out of the target matrix and to secure an efficient transport up to the experiment.

2 The extraction process

In the case of ISOL facilities a requisite for the efficient delivery of short-lived nuclei to the experiment is the fast release of the radioactive ions from the target-ion source-system. The experimentally determined release curves of different elements from specific targets contain components due to the container surface sticking time as well as due to the diffusion out of the target material. The development of analytical methods to simulate this release allows us to understand and if possible determine the relative contribution of each mechanism. We are thus here interested in the transport of the atoms produced by the ISOL method from the place of creation in the target up to the extraction electrode. In this transport there are losses of ions due to radioactive decay. To minimize loss of ions the delay time should be short compared to the lifetime of the atoms. This delay is due to the diffusion out of the target material and to the collisions with the surface of the target material and with the enclosure, this latter we define as effusion. The solid state diffusion is governed by Ficks laws, which have been solved for various boundary conditions [1,2,3]. The temperature is an essential parameter in this diffusion process. The diffusion rate increases rapidly with increasing temperature, however the target must be kept within a certain temperature range during the process in order not to breakdown. The temperature (T) dependence of the diffusion can be described by the Arrhenius equation:

$$D(T) = D_0 e^{-E_a/kT}\,, \tag{1}$$

where D_0 is a constant dependent on the target material and of the properties of the diffusing material, E_a the activation energy and k Boltzman's constant. Once the created particle has diffused to the surface, the subsequent effusion is determined by the average number of collisions with the surface of the target and enclosure, the mean

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sticking time per wall collision, $\tau_{\rm sorp}$, and the mean flight time between two wall collisions. The sticking time, is as the diffusion a function of temperature as described by the Frenkel equation [3]:

$$\tau_{\rm sorp}(T) = \tau_0 e^{-\Delta H_{\rm sorp}/kT}\,, \qquad (2)$$

where τ_0 is a surface-dependent constant in the range of $\approx 10^{-13}$ s, $\Delta H_{\rm sorp}$ the desorption enthalpy. When no experimental data exist, the desorption enthalpy can be deduced using the semi-empirical model of Eichler *et al.* [4]. The database is thus stored with the characteristic parameters of the diffusion and effusion processes which then can be used for the simulation of the whole release process (diffusion, effusion and decay).

3 Database and Web application

The advent of the Internet and advanced computer capability has produced a new generation of Web-based applications. In this context a database plays the vital role of storing and accessing the parameters of interest. Web-based applications are intended to facilitate the use of the computational resources located in different physical sites, thereby allowing users at different locations to easily access information and communicate with each other. Web-based applications thus offer scientists the opportunity to share their data and information with others within the research community by providing a suite of collaboration tools.

The TARGISOL-database [5] contains a collection of tables (entities) connected in a series of relationships that reflects the process and the delay parameters involved in the production and delivery of intense beams of rare isotopes. For the diffusion process, eq. (1), the parameters included in the database are: the constant D_0, the activation energy $E_{\rm a}$, the diffusion coefficient D, and the temperature T for which the diffusion D of an element (Z) in a certain material (Z-target) has been measured. The parameters contained in the database related to the effusion process, eq. (2), is the desorption enthalpy $\Delta H_{\rm sorp}$. All the data contained in the database can be traced back to the reference in original work. Apart from diffusion, effusion and yield entities, there is complementary information stored in the database. A table with general information about each element allows to access atomic, physical and thermal properties of the selected element. All entities are connected via logical relationships making it possible to access any combination of them.

The data of the database are, in order to maintain the quality of the stored information, collected from the literature and from several research organizations under the criteria of being published in refereed journals or books. The database is managed by a relational database management system, RDBMS, and can be accessed through the user-interface both by a retrieval system and/or applications programs. An internet browser-based user interface to the Oracle Relational Database, Rdb, has been created to provide a quick and simple querying procedure.

To enhance communication with the database a Web application has been integrated. Standard HTML pages and embedded PL/SQL code constitute an Oracle PSP file. The PSP files are actually stored in the Oracle Rdb and provide direct query access to it so that the process to retrieve information becomes quick and secure. The HTML pages use forms that include test entries, check boxes, and radio buttons. These graphical tools provide the interactive interface to the user. The PSP files contain server-side script commands that build an SQL search string based on the user selection and input. After an user submits a query request from the web page, the PSP script commands execute on the database via the PL/SQL gateway, the database retrieves the data which uses the PL/SQL Toolkit to return the data in HTML format. Graphical representations of retrieved data is embedded in the HTML page using Java Applets.

4 Summary

With the evolution of Internet technology, there is an ever increasing interest in using the Web as a new platform for scientific applications. For Web applications a database plays the vital role of storing and accessing the simulation data. DifEfIsol Database and Web-Application provides an intelligent Web interface so that scientists can access release parameters of the extraction of radioactive ions from a target-ion-source-system using a standard Web browser from remote sites. DifEfIsol will be very useful for the next generation of Radioactive Ion Beam (RIB) facilities because target-ion source systems can be simulated with different composition, geometry, temperature, beam energy in advance for optimum design of new targets

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