

Development of the virtual light microscope for a material science virtual laboratory

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Education and research trends

ABSTRACT

Purpose: Article describe an idea, bases and construction procedures of Material Science Virtual Laboratory.

Design/methodology/approach: As an example of virtual laboratory post a virtual light microscope used in metallographic investigations is presented. It allows to study the microstructures from different materials and alloys without use of real microscope placed in real laboratory. The only necessary equipment is the computer with internet connection.

Findings: Continuous progress in computer technology and observed growth of computational power opens for material engineers new ground of computer scientific activities with use of virtual reality and computer technologies.

Research limitations/implications: The virtual laboratory, even the best programmed, will never be better than the modest real laboratory, but it is good for training and as introduction to further investigations on a real equipment in real laboratory.

Practical implications: Virtual reality can be efficiently applied to processes of education, increasing of qualifications and for basics, predefined experiments

Originality/value: In spite of considerable creation difficulties, virtual laboratory is a future solution for environments with limited apparatus supplies.

Keywords: Computational material science and mechanics; Virtual reality; Light microscopy; Computer aided simulation

1. Introduction to virtual laboratory

Material Science Virtual Laboratory is an idea, that is very helpful to complement the work for persons interested in acquiring skills and abilities from field of engineering materials and for persons wanting to effect their investigations with use of equipment, to which they do not have access, or which they do not want to serve, because of inadequate knowledge on it's working [1-2].

In the virtual reality, the laboratory devices are replaced by corresponding to them computer programs created in different

programming languages and technologies (e.g. Flash, Java, Delphi, C++). They are virtual reproductions of real equipment installed in real laboratory. User on his computer screen have a new possibility for realization of several defined tasks from given field answering to the given device. [Fig.1], [3-4]

2. Comparison between virtual and real laboratory

Work at home with use of computer is more and more popular. More and more of colleges and institutions are engaged

in similar projects building their own virtual laboratories helping in different fields of knowledge, not only in material science. This makes the work more attractive and creates new possibilities for self-education for the students and employers. It expands also the interest for new field of science.



Fig. 1. The conception of the Virtual Laboratory - replacement of expensive equipment by the computer simulations in the virtual reality on the initial level of laboratory practices [11].

From didactic point of view, virtual laboratory can be treated as a basic form of learning previous to work on the real equipment. Remote or e-learning students without exercises in real laboratory should have their classes in the virtual reality as well. It could be also an exchange form of theoretical knowledge to practical competence.

The possession of practically imperishable equipment will certainly encourage students to individual researches and experiments. Inexperienced users can affect experiments without threatening to their life or to health and without anxieties for the equipment damage caused by unsuitable use. Irregular service will end only with simulated irregular work of machine or with damages only on the computer screen. Then it suffices to restore the settings to the initial state and repeat the experiment with the new setup. Possible to the execution will be however only earlier prepared and conducted model experiments. The true investigative work is impossible to obtain.

World investigations guided at academically universities proved, that the possibility for practicing the given task beyond the laboratory and beyond the control of the supervisor have positive influence on the students' morale. They do not feel helpless and lost during the practice on the classes. The number of incidents and damages caused by their light-hearted behavior is a lot smaller than usually. Prepared students do not act recklessly in the situation, when the bad note is threatening. They know the behavior of equipment and know how to behave leading the investigations. [3-7]

3. The building principles of the virtual laboratory posts

Programs, which are simulating the work of real devices, should be their possibly faithful imitation. It is naturally, that the simulation will never reach the full compliance of the real equipment. The simulation programs should describe most function as possible of the original, in peculiarities these, which are used in training. The faithfulness of the simulation is particularly the most important factor in this case, because it has

the cognitive character for persons, with are not acquainted in the equipment service. [Fig. 2,3]

The full principles of the machine guidance can be introduced only using the real device. Simulations have mostly bounded functionality. Present are only the basic function of the machine, which are necessary for realization of the chosen investigation and they were distinguished from the whole. The training experiments on virtual equipment are perfect for skills gathering which can be very useful later for operating this equipment in the reality.

The user during the work with the simulation should exactly understand the principle of the simulated real device; he should be acquainted with the way of the service and get to know the methodology of carrying out practices and experiments. Possession of this knowledge makes possible free and safe execution of the problem during the work in real conditions, without the continuous looking to the manual, or asking persons which are already trained in this service about every detail.



Fig. 2. The real laboratory post with the light microscope Leica MEF 4A / M placed in the Institute of Engineering Materials and Biomaterials at The Silesian University of Technology [11].

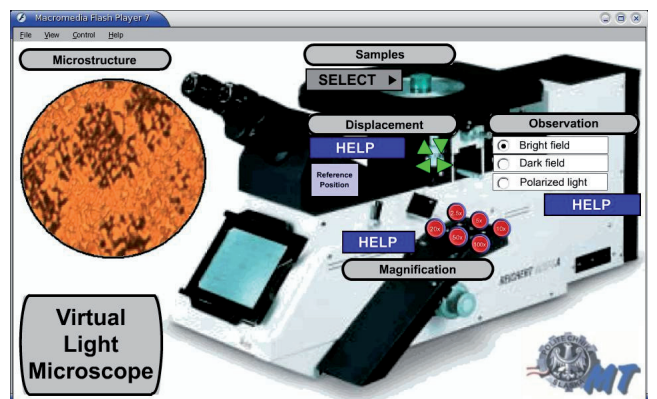


Fig. 3. The working post of the virtual laboratory - Virtual light microscope accessible on every computer with access to the global net.

It should be kept in mind, that even the best-programmed virtual laboratory will never replace even the modest real laboratory. These systems should not be treating as equivalent and one system should not be exchange on the second one. Virtual and real technologies are complementary to each other. Applied together offer more possibilities then applied independently from each other [5-10].

4. The virtual light microscope post

The virtual microscope was made in the programme for creating the interactive web pages content - Adobe Macromedia Flash. This allows the access to the microscope for users without the regard on the used operating system. The functionality of the microscope was tested in systems Windows 98/Me, Windows 2000/Xp, Mandriva Linux 2006, and FreeBSD, without any problems in every case [12-15].

Metallographic light microscope allows disclosing the microstructure of the materials that cannot be seen during the macroscopic observations. Presented virtual laboratory post simulate the Leica MEF 4A / M light microscope. It makes possible to experience the internal structure of many materials modeled and introduced to the system as virtual samples.

Simulator program makes accessible the basic functions of this device, such as the displacement of the subjective table, the change of the magnification and observations method (Fig. 4-8).

Similarly as in the real microscope, when the chosen functions are called out by use of the levers or knobs, in the virtual machine, the functions are executed by the mouse „clicking” on the suitable screen button or by pressing the suitable key on the keyboard.

To facilitate the service of the microscope the handy help buttons were placed near to every steering panel. They describe the work principle of given function of the microscope, the arrangement of elements in real machine, and the usage and service method of this function in the simulation [11, 16-18].

5. The short manual instructions of the microscope usage

Clicking on the suitable icon in the used by us operational system will start the simulation of the microscope. The observation should begin by choosing the interesting virtual sample of the material, what is possible through the sample menu and the choice of the required name of the material from the given list. The next step is the observation method, select one from three options available in the observation panel. After that, we should choose the demanded magnification clicking on one of the red buttons. Now the microstructure of the chosen material can be watched in the observation window. Examples are presented below. (Fig. 9) The view of the sample can be shifted with use of arrow shape buttons placed on the bottom of the subjective table. It is always possible to alter the setup of the microscope by use of appropriate functions. The additional button allows the rollback of the table to the reference position in the case, when the sample runs away beyond the field of observation. In every moment of the work, the contextual help is on our services [11].

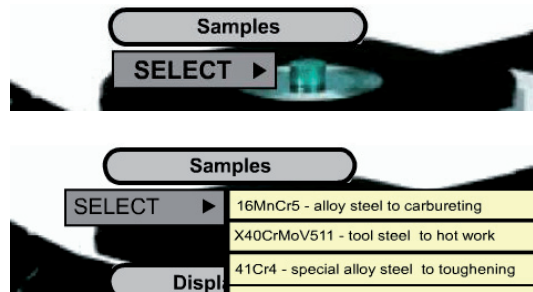


Fig. 4. The sample selection panel.



Fig. 5. The magnification panel.

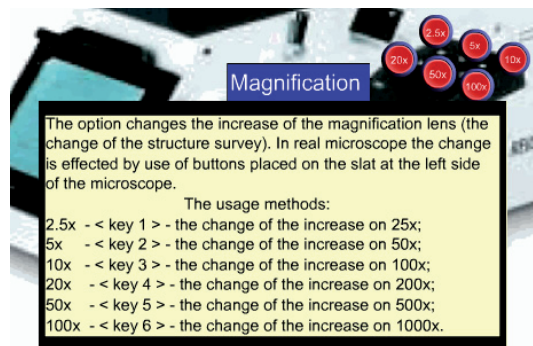


Fig. 6. Additional interactive help on the magnification subject.

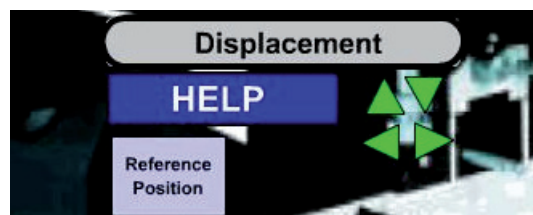


Fig. 7. The panel for displacement of the subjective table.

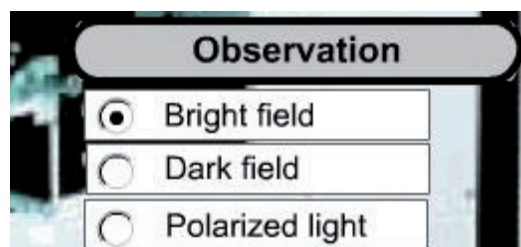


Fig. 8. The choice of the observation method.

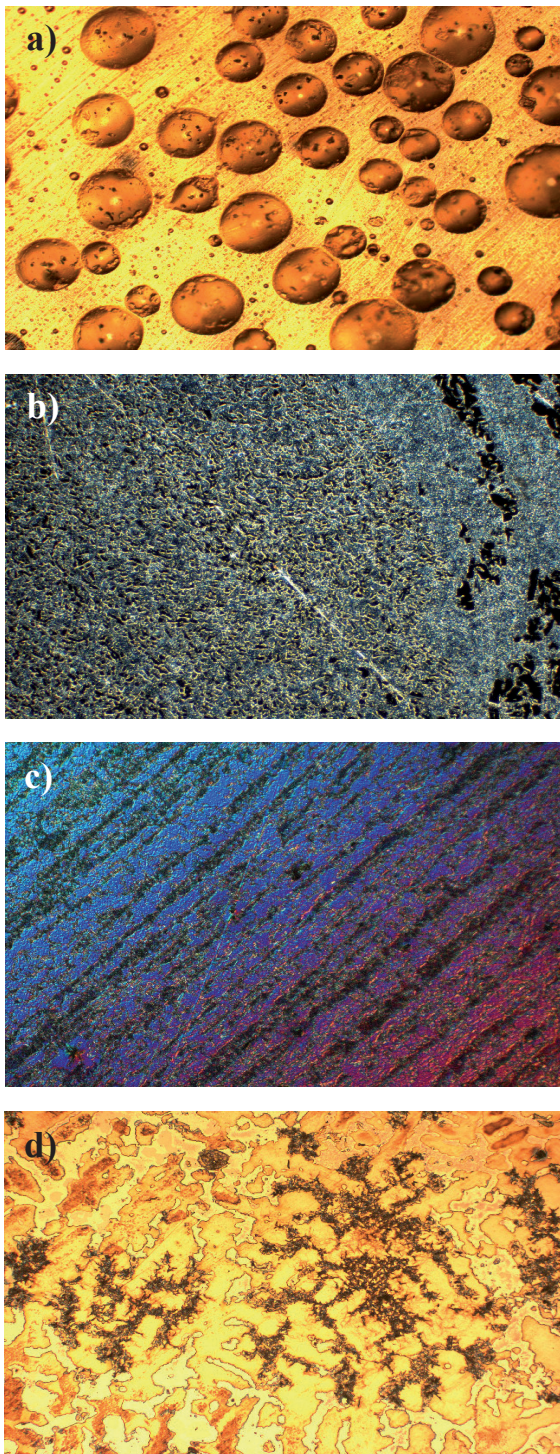


Fig. 9. Examples of several microstructures applied for observation in the virtual microscope as virtual samples. [19]
 a) Bubbles of air in the epoxy resin, magn. 100x, bright field
 b) AlSr10, aluminum - strontium alloy, magn. 500x, dark field
 c) 16MnCr5 steel, magn. 200x, polarized light with contrast
 d) ZlMn1.2, manganese cast iron, magn. 200x, bright field

6. Conclusions

Creation of the virtual laboratory post had in view a reproduction of real light microscope functionality and this aim was reached. Working virtual post gives possibility of access to unrestricted number of students simultaneously and is accessible on every computer connected to the global net. Virtual light microscope is superbly training software for students, which have no experience in work with real equipment. It is also a good practice before accession to real investigations performed in real world.

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