

The Application of Modern Education Technologies in “Nanometer Materials Preparation Experiment Using Sol-Gel Method” Teaching

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Keywords: sol-gel method; network; simulation; experiment teaching

Abstract. Sol-gel method is a traditional preparation experimental teaching item for undergraduates since it is one of the novel effective methods to prepare nano materials. This paper describes the application which the modern education technologies combined with the traditional teaching about the item. The network resources, videos, computer simulation, Monte Carlo software, et. al were developed. By means of these innovations, those abstract concepts and proceeding about Sol-gel method can be understood easily and concretely, the teaching quality and effects can be improved extremely.

Introduction

In the last decades, modern education technologies have been promoting the creation and adoption of new learning and teaching styles[1][2]. It can stimulate the students' enthusiasm to study independently, solve difficult question of teaching. The course of college experiment is very important in improving the student's practical ability and cultivating the compound talents within innovative consciousness. But many drawbacks exist in the traditional experimental teaching which is complex, has difficulties in observing and big expenditure, costs a lot of time, et al. In recent years, we devoted to developing and researching the experimental teaching reform based on the network and computer assistances which is applied to the traditional preparation experiment. It overcomes some limitations of conventional hands-on experiments. This paper describes the application of modern education technologies for sol-gel process teaching about TiO₂ nano materials intended for undergraduates. The network resources, videos, computer simulation, Monte Carlo software, et.al provide the students a learning platform which can understand easily and concretely sol-gel abstract concepts and proceeding, and the quality of experiment teaching was improved extremely.

Assistance Application of Modern Technologies in Experimental Teaching

Sol-Gel Process

Sol-Gel is an organic preparation method and is also one of the wet chemical reactions which is characterized with using a liquid or sol chemical raw reagent rather than the traditional powdery objects.

Since the 1980s, the method has been successfully applied to the material production, for example the composite coatings, functional ceramic powders and the advanced materials which are very difficult to be synthesized by conventional methods. The basic principle of sol-gel is commonly expressed as eqs 1, 2, 3a and 3b:

organic metal salt solvation:



hydrolysis reaction of metal alkoxides:



polycondensation reaction:

dehydration:



dealcoholization:



In our experimental item, TiO_2 powder was prepared by the controlled hydrolysis reaction of $Ti(OC_4H_9)_4$ and $(HOCH_2CH_2)_3N$ which was used as a controlling agent for the hydrolysis to obtain desired products. Eqs 4 is the main reaction of item:



The $Ti(OH)_4$ is stable sol system which contains large amounts of liquid phase, then can be sintered at 400 degrees lower than the conventional calcination temperature, finally turns into the TiO_2 powder [3]. The TiO_2 powder has superb features such as high uniformity and purity due to remove the organic impurities effectively. Especially by changing the process, the different morphologies can be made, such as fibers, powders and films[4][5].

However Sol-Gel method has also some problems: firstly, the raw materials used are expensive, harmful to health; secondly, the sol - gel process required a long time which often took a few days or weeks; finally The Sol-Gel mechanism is very complicated and has not been well-understood by students. So it is common ways of improving education teaching level that explores neoteric teaching methods.

Utilization of Network Resources

Along with the network technology development, the students can study the experiment course contents by themselves on the web. The undergraduates can get much information about sol-gel method or TiO_2 through the electronic library, natural science databases, books retrieval and research BBS, etc. In addition, we should always visit some websites such as <http://www.csu.edu.au/education/library.html>, <http://genchem.chem.wisc.edu/demonstrations/>, and <http://www.Chemsoc.org> and so on. And teachers should list some research questions based on the experiment to students that must submit the answers on one's own, such as the fundamentals and technical development of sol-gel theory. Figure 1 shows the material manufacture process using Sol-Gel method from the internet[6].

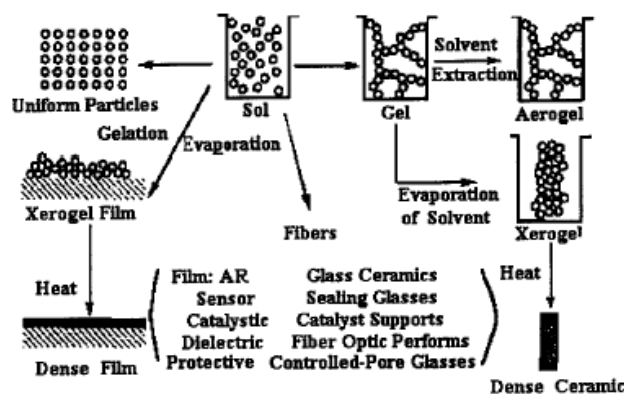


Fig. 1. The Sol-Gel process

Using the Video and Project

In lab teaching, if the video recorder and projector are employed to record or display the actually operational procedures of experiment, the teaching efficiency will be improved greatly. Moreover, these results can be uploaded from teacher's computer to lab intranet so that the students attending class can watch it repeatedly during the experiment, at the same time

standardized the operational skills of the students[7]. Figure 2 shows the main flow chart in in video acquisition and internet transport .

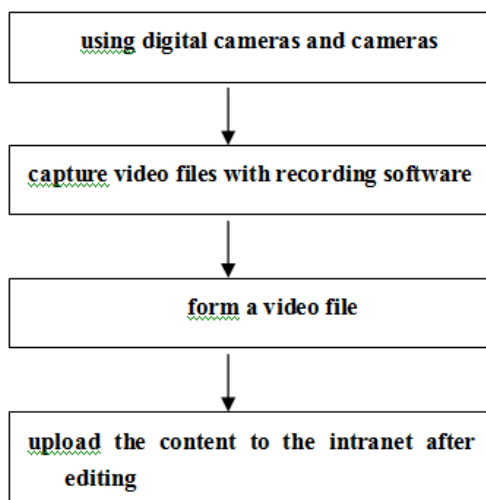


Fig. 2. The flow chart of video teaching

Computer Simulation

Sol-gel method has some advantages with preparing high purity and uniformity nano-sized TiO_2 . However the drawback of this approach is that it is long aging time, vast organic reagent, uncontrolled growth process, all this caused the teaching difficulties of practical experiment. Computer simulation techniques can be used to solve the puzzles, which demonstrates the sol-gel reaction process by solving the mathematical model. Diffusion-limited Aggregation (DLA), Monte Carlo, Finite Element Simulation, Mathematica, et. al, provide effective ways for the simulation of complex reaction process. C++ and origin are also very useful softwares of experimental data processing[8,9]. Especially the Corel Chemlab, it is more intuitionistic and realistic than other tools, increase greatly the interest in simulation learning of student. On the other side, different mathematic models can cause a different simulation result about Sol-Gel experiment. Table 1 shows the TiO_2 micelles morphologies using Sol-Gel method under a variety of kinetics and growth forms models.

Table 1. The Colloidal Particle Structures Under a Variety of Growth Kinetics Models

simulation growth \ kinetic model	kinetic model		
	diffusion control	reaction control	ballistic control
cluster-cluster growth			
monomer-cluster growth			

Conclusion

It is self-evident that the modern education technologies are playing a major role in lab teaching, and have become the important content of educational reform of all countries. Our colleges have made great efforts to use of the modernization network to experimental teaching.

However the application of modern educational technology is in a lower level because of a lack of direct experiences and a shortage of education funds. It will take a long time to realize correctly and most effectively use the modern educational resources, such as software designing, software practices and a powerful combination of traditional and modern educational patterns. This needs our persistence and hard working.

Acknowledgement

In this paper, the research was sponsored by the Natural Science Foundation of Hainan Province (Project No.512115) and the Youth Fund Project of Hainan University (Project No.qnjj1234).

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