# A CASE STUDY ON

# Nanotechnology – Allotropes of Carbon

**by**

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**BASIC INFROMATION:**

Rositsa Sotirova is a teacher in Second English Language School in Sofia, Bulgaria. The lesson "Nanotechnology – allotropes of carbon" was implemented with students in the same school.
Second English Language School is in the capital city of Bulgaria – Sofia.

**INTRODUCTION/BACKGROUND**

- In 1959 the Nobel Prize winning physicist Richard Feynman gave a groundbreaking talk about the physical possibility of making, manipulating and visualizing things on a small scale and arranging atoms "the way we want". Feynman challenged scientists to develop a new field where devices and machines could be built from tens or hundreds of atoms. This field is now called nanotechnology, which has been described as "the science of the very small with big potential".

**(DEFINITIONS/NOTIONS/TERMINOLOGY)**

- Nanotechnology is defined as the research and technology development in the 1 – 100 nm range. Nanotechnology creates and uses structures that have novel properties because of their small size. It builds on the ability to control or manipulate matter on the atomic scale.

**PURPOSE**

The purpose of this lesson is to discuss the structure and application of Carbon allotropes – diamond, graphite and fullerenes, as well as their application in various fields. A specific focus is on nanotechnology.

**OBJECTIVES**

The lesson(s)/activities/project is (are) designed for the *11$^{th}$ grade chemistry students*.

The objectives are:
- To review the covalent bonding principles;
- To understand the allotropic forms of carbon linked to chemical bonding;
- To understand the scales used in chemistry and material science;
- To raise awareness of the application of these alottropes;

The proposed activities allow students to learn about:
- The structure of carbon allotropes;
- The application of buckyballs and carbon nanotubes in nanotechnology
- The crystalline structures

**LEARNING RESULTS**

After completing the activities students should be able to:
- Understand the reason as to why allotropes of carbon exist;
- Make connections between the "micro" and "macro" world linked to real-life applications;
- Understand the difference in the physical properties due to different arrangement of atoms in a crystal;
- Work cooperatively in a group setting

**CLASSROOM MANAGEMENT & SEQUENCE OF EVENTS**

***1. Group Activity – modeling/origami***

- ***Group 1 – activity 1(graphite);***

- ***Group 2 – activity 2(diamond);***
- ***Group 3 – activity 3(buckyball);***
- ***Group 4 – activity 4(nanotubes).***

***2. Discussion - questions***
***3. Quiz***
***4. Fill-in the blanks – summary and conclusions***

**RESOURCES**

Power point presentation

Discussion
Group work – modeling

http://htwins.net/scale2/
*Materials:* modeling clay, polystyrene, sticks, paper, Internet, projector, computer

**PROCESS (ENDING)**
The Quiz and the "Fill in the blanks" activities are used to summarize the lesson objectives and assessment as to the extent students understood the concepts. An extention to this lesson is a homework given to students to research an application of nanotechnology and share it with the class in a form of a poster or presentation.

**ASSESSMENT SUGESTIONS**
- Question for discussion – see power point;
- Quiz – individual work
- Homework - research

**IMPACT ON STUDENTS**
Students enjoyed working in groups and collaborating with classmates. They learned visually and managed to apply the knowledge in problem-solving activities (question session for discussion).

**STUDENTS' FEEDBACK**
***Expressed feedback***:
- The focus on real-life application was appreciated by the students;
- Working in groups was productive;
- The use of different scales and awareness of the micro world was important.

***Processed feedback (graphical results)***:
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(Diagrams/Graphs)
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**CONCLUSION**

The activities planned worked well and students were actively involved in their learning. The lesson objectives were fulfilled successfully. Hands-on activity – modeling combined with video visualization was a great way of engaging students.

**References**

Project Number 511787-LLP-1-2010-1-TR-KA3-KA3MP

Videos

http://htwins.net/scale2/

Links

http://vlab.ntse-nanotech.eu/NanoVirtualLab/

http://ntse.ssai.valahia.ro/

**Images/video taken during the activity/project/lesson(s)**