Designing the K-12 Teaching Modulus of Photonic Crystal and Lotus Effect via Concept Maps

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Outline

Concept Map of K-12 Nanotechnology Education عيدوالله

The need of concept maps in designing teaching modulus for Nanotechnology education

- The teaching modulus of lotus effect عليه وسلم
 -) Concept Map of Lotus Effect
 -) K-12 science curriculum & Benchmarks
 -) The hands-on experiments of lotus effect

The teaching modulus of photonic crystal عيدوسلم

-) Concept Map of Photonic crystal
- K-12 science curriculum & Benchmarks
- The hands-on experiments of lotus effect

Conclusions عليه وسلم

Concept Map of K-12 Nanotechnology Education



The need of concept maps in designing teaching modulus

Concept maps guides to an in-depth learning of lotus effect على الله



This is lotus effect

Contact angle >120° Super-hydrophobic



Nanoparticles makes lotus effect



The basic knowledge of lotus effect

Surface energy / Surface tension 4-force balance system



The need of concept maps in designing teaching modulus

Concept maps guides to an <u>in-depth learning</u> of photonic crystal على الله

For example

This is the phenomenon of photonic crystal

Color dependent selected-reflection Color changes with the angle of sight



Periodic nano structure makes the phenomenon of photonic crystal



The basic knowledge of the phenomenon of photonic crystal

Interference of light 🧤 A



The need of concept maps in designing teaching modulus

Base on the concept maps, one can make some strategies.

-) Look the basic knowledge up in the K-12 science curriculum
-) Systematically design a series of experiments to integrate nanotechnology into the K-12 science curriculum

for example:

Senior high school grades 10-12







Hands-on experiment

The Teaching Modulus of Lotus Effect





Concept Map of Lotus Effect



Lotus Effect: K-12 science curriculum & Benchmarks

	science curriculum	Benchmarks of Lotus effect
K-2		認識自然界中具有蓮葉效應的植物。 Recognizing the plants that naturally have the property of Lotus effect.
3-6	Capillary	認識自然界中的蓮葉效應及其可在生活中進行的應用。 Recognizing the Lotus effect and its applications in our daily life.
7-9	Composition of forces Balance of forces	探究蓮葉效應之現象與原因。 Investigating the phenomenon and the whys of Lotus effect.
10- 12	Surface energy Surface tension	理解蓮葉效應之疏水性。 Understanding the hydrophobic property of Lotus effect.

Grade K-2

Observing the water falling on the plants in your campus!



Leaf of lotus



Leaf of water lily



Touch The Plants and feel them!

Those which forms water droplets are hairy!



Human-made Lotus Effect



The Application of Lotus Effect



Grade 3-6

Observe the water drop on the plants in your campus!



Leaf of lotus



Leaf of water lily



Super-hydrophobic vs. Super-hydrophilic & Interfaces





自潔作用

super-hydrophobic

Draw the tangent line & measure the contact angle



圖 12:玻璃罐和塑膠罐裝水 (盧秀琴拍攝)

圖 13:數位相機拍攝水和兩種罐子的接觸面 (盧秀琴拍攝與繪製)



圖 14:使用量角器量測量接觸角,延著水面找到接觸點,從切線測量接觸角。(盧秀琴繪製)





Sliding or rolling? How does it feel & look?



Three interfaces & forces



4-force balance system



Hydrophilic vs. Hydrophobic



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Grades 10 - 12



The Contact angle of Water on a surface

Learn the skill of measuring the contact عليه وسلم

-) Correctly take a photo of water on a surface for measuring the contact angle
-) Correctly draw the tangent lines of the three interfaces



Human-made Lotus Effect: Toner Powder





CMYK color model: Mixture of Color Toner powder







Capillary: Contact Angle of Water on Materials





Capillary: Contact Angle of Water on Toner powder



The interface between water and toner powder has very high surface energy.



Reducing the surface energy

High surface energy refers to a high surface tension.

- The contact point tends to move along the direction which reduce the total energy.
- The force system reaches balance as the total energy reaches the lowest one.



How to Make a Surface Have Lotus Effect?

صلى الله Nanoize the surface



Self-Assembly

Self-Assembly is due to process of reducing total energy.

The force system of a self-assembly is very complicated.



Self-assembly of plastic spheres





The Teaching Modulus of Photonic crystal



Concept Map of Photonic Crystal



Photonic Crystal: K-12 science curriculum & Benchmarks

	Science curriculum	Benchmarks of photonic crystal
K-2		認識具有光子晶體的生物或物品。 Recognizing the organism and things that have the property of photonic crystal.
3-6	Reflection of light Refraction of light Rainbow Color TVetc.	察覺材料尺寸趨於奈米尺度時性質會發生改變,並認識其 在自然界的現象和奈米科技中的應用(如彩蝶效應)。 Recognizing that the properties of matter will be changed when the size of the matter reduces to nanoscale range. Recognizing the natural phenomenon and the applications of nanotechnology. (e.g. the brilliance of a butterfly wings)
7-9	RGB color model	認識彩蝶效應是由於奈米結構所造成。 Recognizing that the brilliance of a butterfly wings is resulted from the nano structures on the wings.
10- 12	Single-slit double-slits Grating	理解光子晶體由特殊週期排列的奈米結構造成,為彩蝶效 應形成之原因。 Recognizing that photonic crystal is constructed by periodic nano structures. This is also the origin of the brilliance of butterfly wings.



Grades K-2



Euploea purple butterfly

圖 1-2 紫斑蝶遷移路線 資料來源:台灣蝴蝶保育學會(2010)。 茂林國家風景區的紫蝶介紹,http:// www.maulin-nsa.gov.tw/maolin/ii/ introdution.html

K-2, which one has the phenomenon of photonic crystal



奈米阿寶 (雷射貼紙)



紫斑蝶姊妹花

跳舞老皮 (彩虹膜)



蝶舞春風 (青斑蝶)



戀愛皮卡丘 (色紙)



玉子燒 (便利貼)



開心機器人 (花片)



火焰熊拳 (光碟片)

Grades 3-6



Dispersion of light

source of light : Sun





source of light: LCD projector





The light form LCD projector



Its color is purple, but it is not purple light.





red light purple blue light

Physical color? Chemical color?



Drop 95 % alcohol to this two area







The Structure of Butterflies' wings



Make a periodic structure!!

將30至50片薄刀片整齊疊在一起









Polarized Light (LCD Projector) and Polarizer





LCD = Liquid-Crystal Display

Non-Polarized Light (DLP Projector)



DLP = Digital Light Processing

The periodic nano structure





放大50倍

放大200倍





放大5000倍

放大1000倍

Grades 10-12









http://volga.eng.yale.edu/index.php/CDsAndDVDs/MethodsAdMaterials



光子晶體是在1987年由S. John和E. Yablonovitch分別獨立提出

北子冒體

-) 它是由不同折射率的介質周期性排列而成的人工微結構,高介電係數的物質, 其折射率也高。
- 當介電係數的變化足夠大且變化周期與光波長相當時,光波的色散關係出現帶 狀結構,此即光子能帶結構(Photonic Band structures)。這些被禁止的頻率區 間稱為「光子頻率帶隙」(Photonic Band Gap, PBG),頻率落在禁帶中的光 或電磁波是被嚴格禁止傳播的。



One-Dimensional Photonic Crystal (Mutilayers)







利用半導製程顯影與蝕刻的方法來製作

) 把高介電常數的物質作規則排列



高介電常數排列 (中央大學電機所詹益仁教授)



光碟儲存單位元的光子晶體現象





三維光子晶體

3D-photonic crystal can be made by the self-assembly process of plastic nano ball.





Photonic Crystal Wave Guide

Light propagates along the defects of a periodic structure. This make one has chance to use light to pass signals.



Conclusions

Base on the concept maps, one can make some strategies to design teaching modulus of nanotechnology.

The teaching modulus of photonic crystal and lotus effect على المعاركة are successfully designed via the concept maps.