The future of air cleaning

空氣淨化的未來

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Small is beautiful for CityU scientist Dr Oscar Hui Kwan-san, even though his work is in the exceptionally broad discipline of environmental engineering.

The synthetic materials Dr Hui constructs—measured in nano scale—are the key to a novel energy-efficient technology that can be used in air filters to remove VOCs (volatile organic compounds), an undesirable air-borne substance.

The VOCs are transformed into water and carbon dioxide after they flow through the filter and react with the catalysts and ozone, a process that Dr Hui calls ozone catalytic oxidation (OCO). Copper oxide and cobalt oxide are two of the catalysts used in the process.

"The new nano materials make it easier for VOCs to decompose. This greatly increases removal efficiency, and also cuts down energy consumption," said Dr Hui, Lecturer in the Department of Systems Engineering and Engineering Management.

Perhaps most importantly of all, Dr Hui's OCO technology makes it possible for the chemical process to take place at room temperature, whereas normally VOCs can decompose only at temperatures of 400 to 500 degrees Celsius.

The technology offers potential for the development of a more efficient generation of home-use air cleaners. At present, home-use air cleaners adsorb VOCs through a filter, but cannot break down VOCs into earth-friendly carbon dioxide and water.

"Decomposition is preferred to adsorption because the adsorbents in the filter have limited capacities and need to be frequently replaced.

What are VOCs?

VOCs can be commonly found in modern offices or homes with poor ventilation. They are released from furniture, cleaning products, and solvents in paint and construction materials.

VOCs can cause adverse health effects such as allergic reactions, tiredness, and even cancer.

什麼是「揮發性有機化合物」？

揮發性有機化合物常見於通風不暢的現代辦公室或住宅。傢具、清潔劑、油漆中的溶劑、建築材料等物質，均會釋放出這種化合物。

揮發性有機化合物對人體健康有不良影響，可引起過敏反應，令人疲倦，甚至會致癌。

If not properly maintained, the adsorbent may even release VOCs back into the environment," explained Dr Hui, adding that future air cleaners using OCO technology would reduce the frequency of replacing filters.

Dr Hui's research team recently received a government grant worth HK$999,994 and another HK$200,000 grant from two private firms to develop a decomposition-based air cleaner prototype.

The challenge now is to make highly efficient nano materials loaded with active and stable catalysts and look for a combination that results in the fastest reaction.

He added that the next new material in line for testing is graphene, which physicists and chemists favour because of its unusual physical and chemical properties.

The next step is set to develop nano-sized, graphene-based functional materials to resolve the problem of indoor air pollution.

對城大科學家許冠山博士來說，「小即是美」，儘管他的研究領域是異常廣闊的環境工程學科。

許博士創造的合成材料細小到須以「納米」量度，以此為關鍵的一項新節能技術若用於空氣淨化器的濾芯，可清除飄浮在空氣中的有害物質—揮發性有機化合物（VOC）。

揮發性有機化合物流經這種新濾芯時，與其中的催化劑及臭氧產生反應而變成水和二氧化碳，許博士稱這個過程為「臭氧催化氧化」（OCO）。氧化銅與氧化鈷是這一過程中使用的兩種催化劑。

「這些新型納米材料用作催化劑，使得揮發性有機化合物較容易分解，大大提升了清除的效率，同時亦減少能源消耗，」許博士說。他是系統工程及工程管理學系講師。

也許最大的好處是，許博士的「臭氧催化氧化」技術使得這個化學分解過程可在室溫下進行，而揮發性有機化合物通常要在攝氏400至500度的高溫下才會分解。

藉著這項技術，有可能研製出新一代的高效率家用空氣淨化器。目前的家用空氣淨化器只是利用濾芯吸附揮發性有機化合物，不能把此類物質分解為無害於地球環境的二氧化碳和水。

「分解勝過吸附，因為濾芯裏的吸附劑的容量有限，必須時常更換。濾芯如果維護不當，甚至可能把吸附的揮發性有機化合物再度釋放回空氣中，」許博士解釋說。他還說，未來的空氣淨化器使用「臭氧催化氧化」技術，濾芯不必頻繁更換。

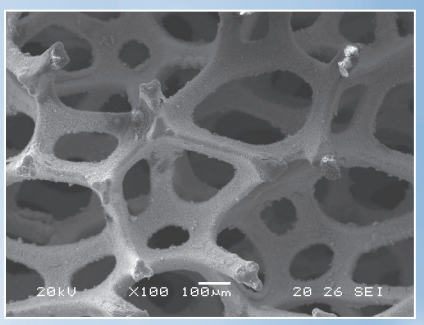
最近許博士的研究小組獲得了999,994港元的政府補助金，同時又獲得了兩家私人公司20萬港元的資助，用於研製一部分解式空氣淨化器的原型。

目前的難題是製造高效率的納米材料，用以承載活躍而穩定的催化劑，並找出能促成最快速反應的催化劑組合。

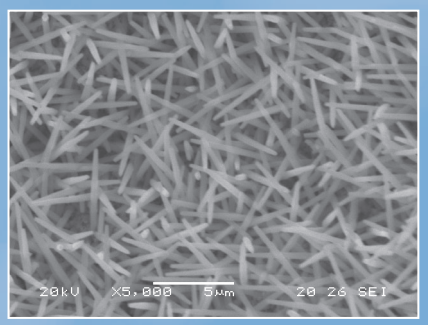
他說，接下來要測試的新材料是石墨烯。這種材料很受物理學家與化學家的青睞，因為它具有罕見的物理與化學性能。

下一步就是用石墨烯研製出納米尺度的功能材料，以解決室內的空氣污染問題。

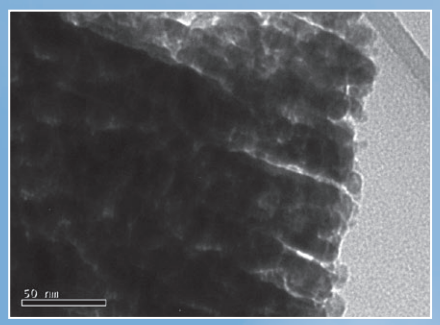
One of the nano catalysts grown on 3D porous support successfully developed by Dr Hui
許博士研製的納米催化劑塗在三維多孔載體上



View under a scanning electron microscope (X100 magnification)
在掃描電子顯微鏡下放大100倍



View under a scanning electron microscope (X5000 magnification)
在掃描電子顯微鏡下放大5000倍



The morphology of the catalysts (under a transmission electron microscope)
在穿透式電子顯微鏡下催化劑的形態