單晶晶圓二維材料長法

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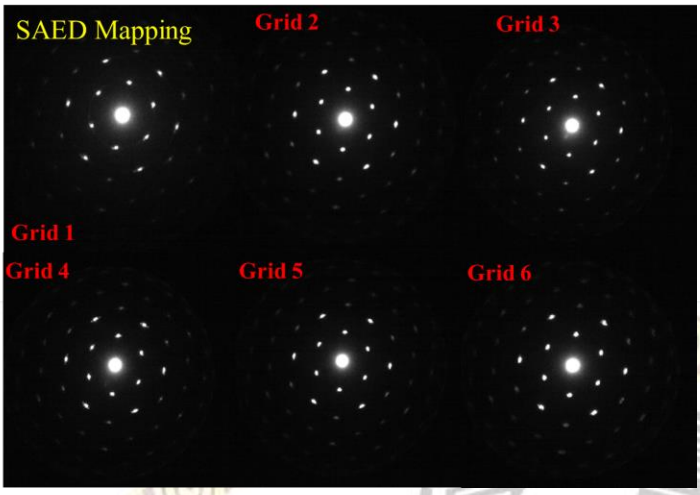
市場及需求:

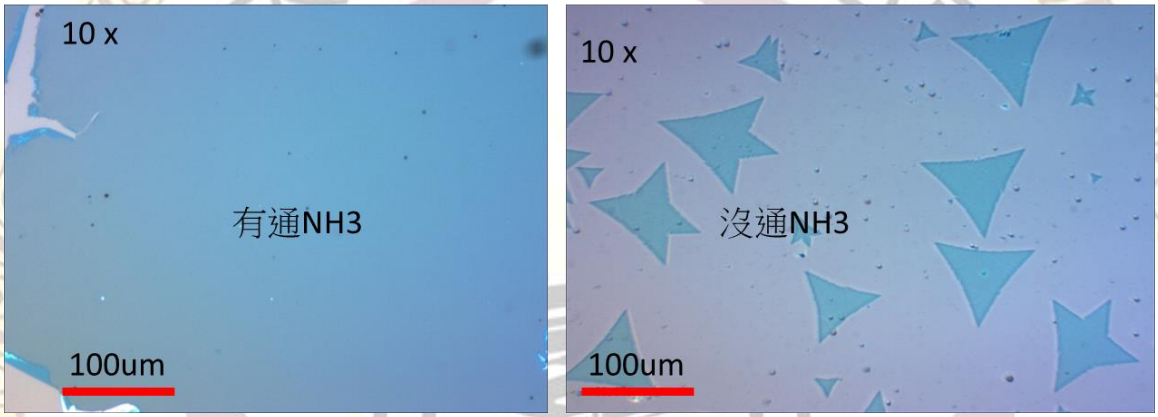
二維過渡金屬二硫族化物((transition metal dichalcogenides，簡稱 TMDCs) MX_2 (M: Transition Metal , such as V, Nb, Ta, Cr, Mo, W, Ni, Pd, Pt; X: S, Se, Te), 在單層晶體結構與石墨烯相似，其中，如二硫化鉬(MoS_2)、二硫 化鎢(WS_2)、二硒化鉬($MoSe_2$)、二硒化鎢(WSe_2) 等, 歸屬於二維層狀半導體材料，而部分歸屬金屬或絕緣體材料。如同石墨烯, 此種單層二維且只有原子層厚度的材料。目前除了石墨烯之為，只有半導體二維材料是可以在市面上買的到，但市面上的二維半導體材料因生產方式極沒效率，售價約為 $1cm^2$=500 USD. 且品質不佳，非單晶，價格昂貴，因此不具商業化價值。
本專利是生產二維過渡金屬硫化物的製程，目的在生長可提供商業化需求之質與量的晶片—單晶晶片(整片晶圓原子排列一致)。
二維半導體材料的應用，一直以來都是侷限於材料的尺寸及品質。從未有可商用化的單晶連續均勻的晶圓尺寸被成功生長出來。因此侷限住商業化的應用，使得可撓式電子元件及取代矽基板受到阻礙。目前預測的應用如下:
首先，目前二維材料為奈米領域研究的主要材料，因此預期將會有學界的需求。
另外，由於電晶體已經到了尺寸的極限，要更縮小尺寸，首先半導體材料的厚度必須先降低。而二維材料是世界上最薄的材料。因此二維半導體材料的發展顯得重要。
再者，UV-LED 因為基板而顯得昂貴，而二維材料作為基板，可以提高 UV-LED 的良率，為未來為潛能的應用之一。

技術摘要(含成果):

1. 經過 Sapphire 基板適當的 N_2 或 NH_3 之氮化前處理, 二維材料 TMDCs 將只會成長為一個方向磊晶成長，最後連在一起變成晶圓級的單晶。



2. 在成長的過程中通入 NH3 氣，可以大量的增加生長均勻度。增加長單晶的速度。



優勢:

晶圓尺寸的單晶無邊界大幅降低缺陷，大幅提高商業化應用的可能性。

競爭產品:

傳統 CVD 生長的過渡金屬硫化物

以下為其他賣 CVD TMDC 網頁：

http://www.6carbon.com/product-lab-en.php#CVD-Grown-2D-TMDCs
https://www.2dsemiconductors.com/new-cvd-monolayers/
https://2dlayer.com/film.html#mos2film

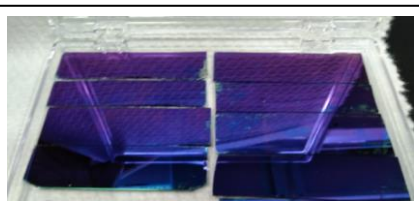
專利現況:

申請中

聯絡方式(請不用填):

Method for growing single-crystalline TMDC in multi-wafer scale

PI： Prof. Ya-Ping Hsieh and Mario Hofmann
Department of Physics, National Taiwan U.



Experience:
http://mylabntu.weebly.com/professors.html

Market Needs:

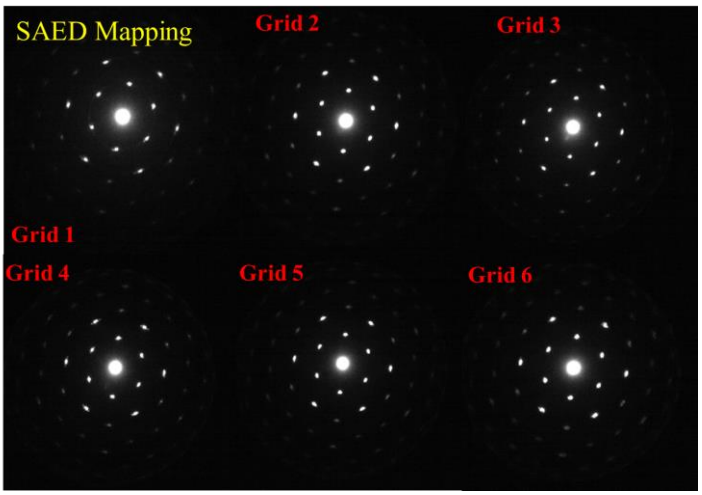
This patent is concerning a process for producing commercially viable single-crystalline quality of two-dimensional transition metal sulfides. Transition metal dichalcogenides, similar in structure to graphene, which are exemplified as molybdenum disulfide (MoS_2), Tungsten disulfide (WS_2), molybdenum diselenide ($MoSe_2$), tungsten diselenide (WSe_2), are two-dimensional layered semiconductor materials. Like graphene, this material class not only exhibits superior performance compared to traditional semiconducting materials, but exhibits special optical properties that make it an enabling material for the next generation electronics and Optoelectronic devices.

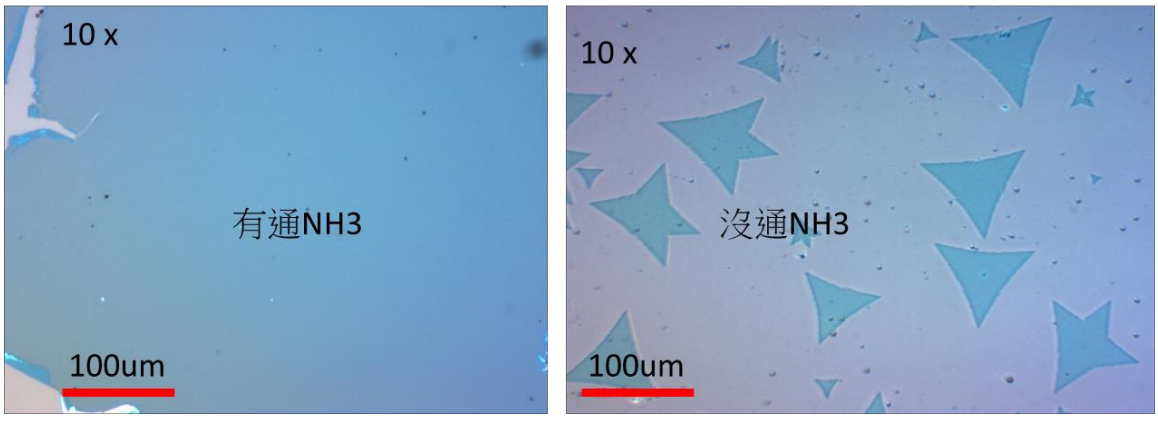
Thus, our advance is promising in several key-areas:

1. 2D materials are the best candidates for Wearable and Transparent, flexible electronics
2. Research on 2D material is an expanding area of nanotechnology with thousands of active research groups that could benefit from our material
3. The semiconductor industry has identified 2D materials as promising structures for next generation electronics components and has added FinFETS to their roadmap of future development.
4. The high crystallinity of our material makes it promising as buffer layer for epitaxial deposition of thin films. Thus, the produced material could provide a route for producing epitaxial layers, as required in UV-LEDs and quantum-well structures, on inexpensive or innovative substrates.

Our Technology:

1. Our advance represents an integrated process of TMDC growth and substrate pretreatment. This combination permits the epitaxial ordering of TMDCs on suitable substrates. Due to the single-crystalline nature of the employed substrates, alignment of the grown TMDCs extends over large scales. Because of the absence of orientation-mismatch, separate grains will merge into a continuous film without extended edge defects.





2. A second result of the developed process is a significant increase in growth speed compared to traditional CVD methods due to a synergistic effect.

Strength:

High-quality, single-crystalline and large area transition metal sulfides can be synthesized at unprecedented scale and quality compared to previous research and available products. Due to the simplicity of our approach, we anticipate to also outperform any other technology in terms of cost.

Competing Products:

There are several companies that sell TMDCs produced by traditional CVD synthesis [http://www.6carbon.com/product-lab-en.php#CVD-Grown-2D-TMDCs, https://www.2dsemiconductors.com/new-cvd-monolayers/, https://2dlayer.com/film.html#mos2film] but their products are of inferior quality and sample dimension which limits their usefulness in the described areas.

Intellectual Properties:

Application in progress

Contact (do not need to fill out):