High-yield production of macroscopic 2D materials

Industry
Materials
Manufacturing

Key Features

- Method for high-yield production of macroscopic 2D materials that are comparable in quality to microscope monolayers formed by Scotch tape exfoliation.
- Many applications in electronics, optics, quantum information science, others.
- $91M opportunity for graphene market alone.

Intellectual Property:
Two U.S. provisional patent applications were filed by Columbia University.

Seeking:

- Entrepreneur
- Team
- Advisors
- Connections

Scientific Advisor
Xiaoyang Zhu, Ph.D.
Howard Family Professor of Nanoscience and Professor of Chemistry at Columbia University

Contact Information
Dovina Qu, Ph.D.
Technology Licensing Officer
Columbia Technology Ventures
212-851-9735
dq2119@columbia.edu

Technology Summary: A research team at Columbia University led by Dr. Xiaoyang Zhu developed a method for high-yield production of macroscopic two-dimensional (2D) materials. 2D materials such as graphene and transition metal dichalcogenide monolayers have a variety of applications in electronics, optics, and quantum information science. 2D materials are often produced using the Scotch tape method, which generates high quality microscopic 2D materials through a simple and inexpensive process. However, the yield is very low and the small flakes associated with Scotch tape exfoliation averts its use in mass production. The method developed by Dr. Zhu's team produces macroscopic 2D materials that are comparable in quality to the microscopic monolayers formed by conventional Scotch tape exfoliation, with the advance of leading to macroscopic monolayers with near unity yield.

Market Opportunity: 2D materials such as graphene have an extensive range of applications including electronics, semiconductors, optics, quantum information science, and others. The global graphene market was valued at $91M in 2019[1]. Market growth is driven by increasing consumer electronics demand[1]. Investment by emerging economics such as India, China, and Japan contributes to growth across the 2D materials market[2]. However, development of cost-effective 2D materials and requirements to meet industrial standards are a challenge for the industry[2]. Thus, this technology has potential to significantly improve 2D manufacturing and use.
[1]AlliedMarketResearch [2]TransparencyMarketResearch

Scientific Expertise: The team is led by Dr. Xiaoyang Zhu, the Howard Family Professor of Nanoscience and a Professor of Chemistry at Columbia University. Prior to joining Columbia University, Dr. Zhu held positions at the University of Texas-Austin as the Vauquelin Regents Professor and director of the DOE Energy Frontier Research Center (EFRC) and the Center for Materials Chemistry; and at the University of Minnesota as a Merck endowed professor. Dr. Zhu was awarded the Dreyfus New Faculty Award, a Cottrell Scholar Award, a Friedrich Wilhelm Bessel Award, APS Fellow, a Vannevar Bush Faculty Fellow Award from DOD, and an Ahmed Zewail Award from the American Chemical Society. He is an associate editor of Science Advances and Journal of Chemical Physics, and is a scientific advisor to the Fritz-Haber-Institute of the Max-Planck Society.

Technology Details: The technology utilizes an ultra-flat metal tape that can be used to exfoliate van der Waals single crystals layer-by-layer, disassembling them into monolayers with nearly 100% yield. Using this high-throughput method, monolayer dimensions are limited only by bulk crystal sizes, and resulting 2D materials can be reassembled into macroscopic artificial structures with controllable properties, e.g., artificially stacked nonlinear optical materials with high efficiencies. This technology is currently being used to create new samples/materials for study in over a dozen laboratories worldwide and in two research centers at Columbia (NSF-MRSEC and DOE-EFRC).

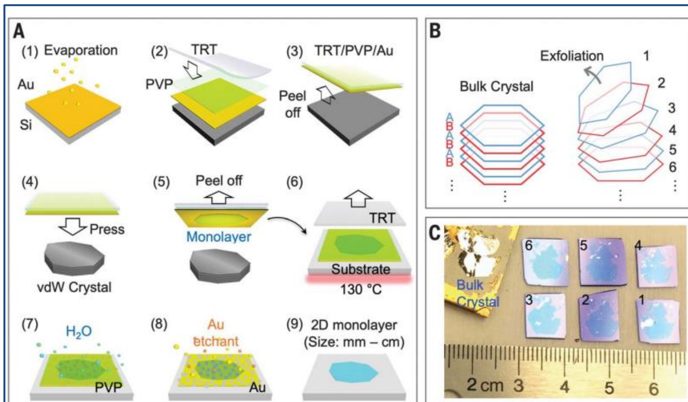

Illustration of exfoliation procedure of bulk vdW single crystals published in:

Liu F, Wu W, Bai Y, Chae SH, Li Q, Wang J, Hone J, Zhu XY. "Disassembling 2D van der Waals crystals into macroscopic monolayers and reassembling into artificial lattices" Science. 2020 Feb 21; 367(6480): 903-906