

## 学術変革領域研究（A）の公募研究の内容（英語版）

### Science of 2.5 Dimensional Materials: Paradigm Shift of Materials Science Toward Future Social Innovation

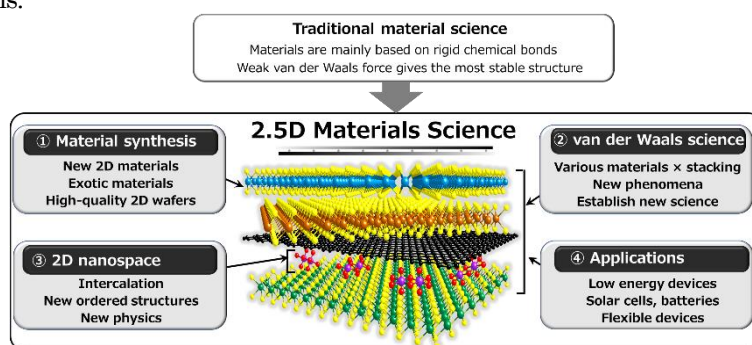
<http://25d-materials.jp>

Number of Research Area	: 21A206	Term of Project	: FY2021-2025
Head Investigator	: AGO Hiroki		
Research Institution	: Kyushu University, Global Innovation Center (GIC)		

#### 1. Details of Research Area

Materials science has established the basis of our modern society through the development of emergent internet of things (IoT) technologies. Traditional materials science is mainly based on the precise control of bulk materials with rigid chemical bonds. On the other hand, two-dimensional (2D) materials, such as graphene, offer novel ways to make new materials by integrating different layers via van der Waals interaction. This is accomplished by artificial stacking of 2D materials with controlled compositions and stacking angles, an approach that is expected to significantly expand the frontier of materials science. Furthermore, well-defined 2D nanospace existing between the layers of stacked 2D materials offer the opportunity to explore novel phenomena and to synthesize new materials.

In this Research Area we propose to explore the "Science of 2.5 dimensional materials" by introducing the new concepts "freedom of integration" and "2D nanospace", in combination with the synthesis of a wide variety of 2D materials. We will develop academic research based on this unique "2.5D" concept to achieve world-leading results, giving rise to upcoming social innovation. This Research Area consists of five Research Groups (A01~A05), and all the members in this area collaborate closely to establish the new scientific field. In addition, the collaborations are supported by the four joint research centers of the groups, allowing access to a wide range of facilities, such as automatic stacking equipment.



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#### 2. Call for Proposals and Expectations for Publicly Offered Research, etc.

In this Research Area, we are developing unique and novel 2.5D material research by integrating the strength of the group members through close collaborations. Therefore, researchers applying to this Publicly Offered Research are strongly encouraged to describe a detailed collaboration plan with some of the group members, in addition to an original research plan (if some collaboration has already been done, please also include the achievements). It is also required to indicate how the proposed research can contribute to this Research Area.

The following are the details of the possible research topics: (1) Material synthesis and assembly: synthesis of novel 2D materials including organic-inorganic 2D superstructures, such as COF and MOF, proposal of new assembly technology of 2D materials, proposal of exploring the potential of 2D nanospace by introducing molecules or new architectures. (2) Analysis: development of new methods to analyze thin 2.5D materials with high spatial/energy resolution and high sensitivity, and new methods to detect defects and impurities of large 2.5D wafers in short measurement time. (3) Physical properties and applied research: research which is not covered with the present members. Topics like strongly correlated electron systems, quantum information, spintronics, terahertz devices, applications in information communication (6G), thermoelectric applications, MEMS/NEMS, and tribology are welcomed. (4) Theoretical solid state physics and quantum chemistry that explain the science of 2.5D materials, enabling the prediction of new physical properties based on the combination of different 2D materials. In addition to the topics listed above, we also seek for proposal on challenging topics that can dramatically advance this Research Area. Finally, we also encourage applications from young researchers and female researchers.

#### 3. Research Group, Upper Limit of Annual Budget and Number of research projects scheduled to be selected

Research Group Number	Research Group	Upper Limit of Annual Budget (Million yen)	Number of research projects scheduled to be selected
A01	Materials synthesis for 2.5D structures	Experimental: 5	4
A02	Assembly for 2.5D integrated structures		
A03	Development of analysis methods for 2.5D structures	Experimental or theoretical: 3	13
A04	Development of novel physical properties with 2.5D structures		
A05	Development of electronic, photonic, and energy applications with 2.5D structures	Theoretical: 1.5	4