We develop useful things using ceramics

Research Institute for Electronic Science

Lab. of Functional Thin Film Materials

Nikkan Kogyo (2018.6.28)


レーザー

太田さん

車の廃熱再利用

▽…「自動車の廃熱再利用で燃費を向上させる」と意気込むのは、北海道大学教授の太田裕道さん。自動車エンジンまわりの高温環境で利用する熱電変換材料を開発する。

▽…原理を実証し、900度Cでの熱電変換にめどをつけた。ただ「半導体の製造法で材料を合成した。自動車向けにはもっと安い製造プロセスで作る必要がある」という。

▽…産学連携が必要な段階だ。「高温や化学的に安定で、毒性元素も使わない。素材としては有望だ。あとは量産方法の確立が課題」と実用化のパートナー探しに奔走する。

Nikkei (2017.12.4)


青色LED材料で 熱を電気に効率変換

■北海道大学 太田裕道教授らは産業技術総合研究所などと共同で、温度差を利用して発電する熱電変換の効率を高める技術を開発した。青色発光ダイオード（LED）に使われる「窒化ガリウム」という材料で作った半導体素子を活用し、電子が動きやすくする工夫を加えた。同じ温度差で熱を電気に変える効率は、金属のビスマスやテルルを使う従来材料の2倍以上になった。工場や自動車などの廃熱の有効利用につなげる。

材料の両端に温度差があると温度の高い方から低い方に電子が動き、電気が発生する。従来の熱電変換素子は材料が高価で普及が進んでいない。

研究チームは電子が移動しやすい窒化ガリウムに注目。この薄膜にアルミニウムを混ぜた窒化ガリウムを載せた。静電気によって薄膜表面に電子が集まり、さらに移動しやすくなり、熱を電気に変える効率が向上した。

Aims of the laboratory

In our laboratory, we focus on functional oxides, so called ceramics. We fabricate high-quality thin films with atomically flat surface. We extract the intrinsic performance of functional oxides. We challenge to develop novel devices. We are developing "Thermoelectric materials", "Transparent Oxide Semiconductors based devices", "Optic, electric, and magnetic memory devices".

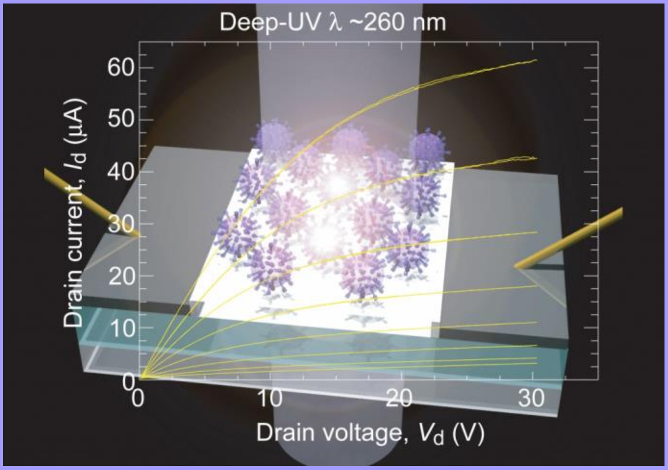
We developed high mobility thin film transistor using cheap SnO_2 as the channel material.

1. Thermoelectric materials

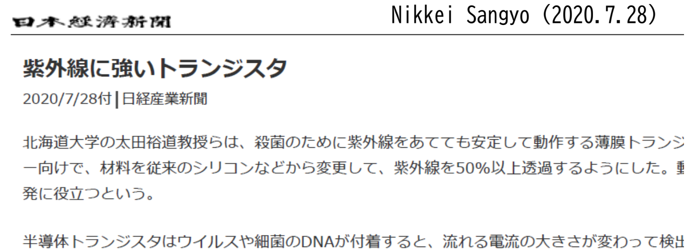
Thermoelectric energy conversion technology attracts great attention to convert the waste heat into electricity. Recently, metal oxides attract much attention as thermoelectric power generation material operating at high temperatures on the basis of their potential advantages over heavy metallic alloys in chemical and thermal robustness. We have fabricated high quality epitaxial films of oxide thermoelectric materials, which are suitable to clarify the intrinsic "real" properties. Now we are trying to clarify the origin of giant thermopower of extremely thin conducting oxide toward realization of truly practical oxide thermoelectric materials.

2. Transparent oxide semiconductors

Transparent conducting oxides such as ITO (tin doped indium oxide) have been used as transparent electrodes for liquid crystal displays and OLED. Our laboratory is conducting research to develop transparent conductive oxide usable as a transparent oxide semiconductor. Specifically, we prepare high quality epitaxial thin films which enables fabrication of a laminated structure, realizing high carrier mobility, and materials that can be put into practical use by lowering the manufacturing cost. We also fabricate high-quality amorphous thin films at room temperature. These high quality thin films allow us to develop diodes and transistors that have been realized with compound semiconductors.



Nikkei Sangyo (2020.7.28)


日本経済新聞

紫外線に強いトランジスタ

2020/7/28付|日経産業新聞

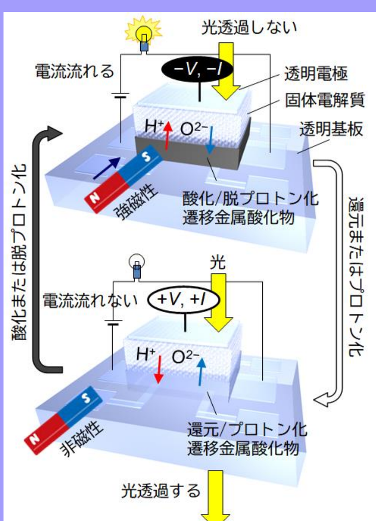
北海道大学の太田裕道教授らは、殺菌のために紫外線をあてても安定して動作する薄膜トランジ
ー向けで、材料を従来のシリコンなどから変更して、紫外線を50%以上透過するようにした。重
発に役立つという。

半導体トランジスタはウイルスや細菌のDNAが付着すると、流れる電流の大きさが変わって検出

RIES, Hokkaido University, N20W10, Kita, Sapporo 001-0020, Japan
TEL +81-11-706-9428 URL http://functfilm.es.hokudai.ac.jp/English/

3. Electrochemical materials and devices

The optic, electric, and magnetic properties of many transition metal oxides can be switched by their non-stoichiometry i.e. oxygen excess or deficiency and protonation. For example, $SrCoO_{2.5}$ with Brownmillerite structure is known as insulating non-magnet, but it can be changed into $SrCoO_3$ with Perovskite structure, which is ferromagnetic metal. For transition metal oxides, water is a strong reductant (H^+) as well as an oxidant (OH^-). Although such memory devices can be realized by using liquid electrolytes for electrochemical reaction, there is liquid leakage problem. We have developed "liquid-leakage-free water", in which water molecules are infiltrated in a nano-porous glass. By using "liquid-leakage-free water", we can switch optic, electric, and magnetic properties of transition metal oxides.



Yomiuri (2016.4.16)


記憶媒体 容量２倍に

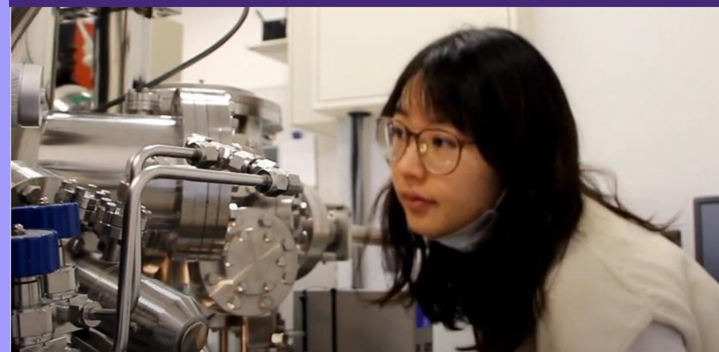
北大教授ら開発 スマホに応用可

HBC NEWS (2016.3.30)

We use pulsed laser deposition technique to fabricate films of ceramics and devices.

ENVIRONMENT

Our rooms are located on the 3rd floor of the RIES building, located in N20W10. In the laboratory, there are thin film manufacturing equipment for making thin films and devices, electric furnaces for making ceramics as raw materials, atomic force microscopes and X-ray diffractometers for investigating the structure of the thin films. There are equipment in place for all basic analysis.



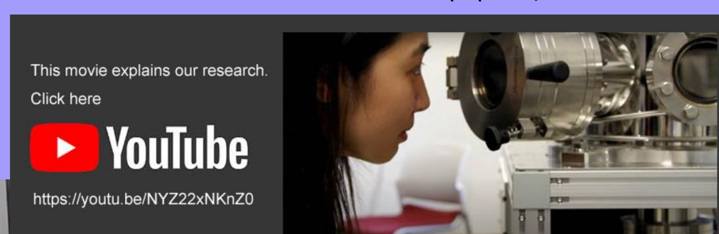
The senior students kindly teach you how to use the equipment.

Skills acquiring in the laboratory

[1] Communication in English through the lab meeting (Language: English)

[2] Explanation skill: Students give presentations at international / domestic conferences.

[3] Appealing skill: Publishing SCI journal papers (Master's course: more than 2 papers, Doctor's course: more than 3 papers)



For more detail, please watch the YouTube movie

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