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應用物理及材料工程研究院
INSTITUTO DE FÍSICA APLICADA E ENGENHARIA DE MATERIAIS
INSTITUTE OF APPLIED PHYSICS AND MATERIALS ENGINEERING

IAPME Newsletter

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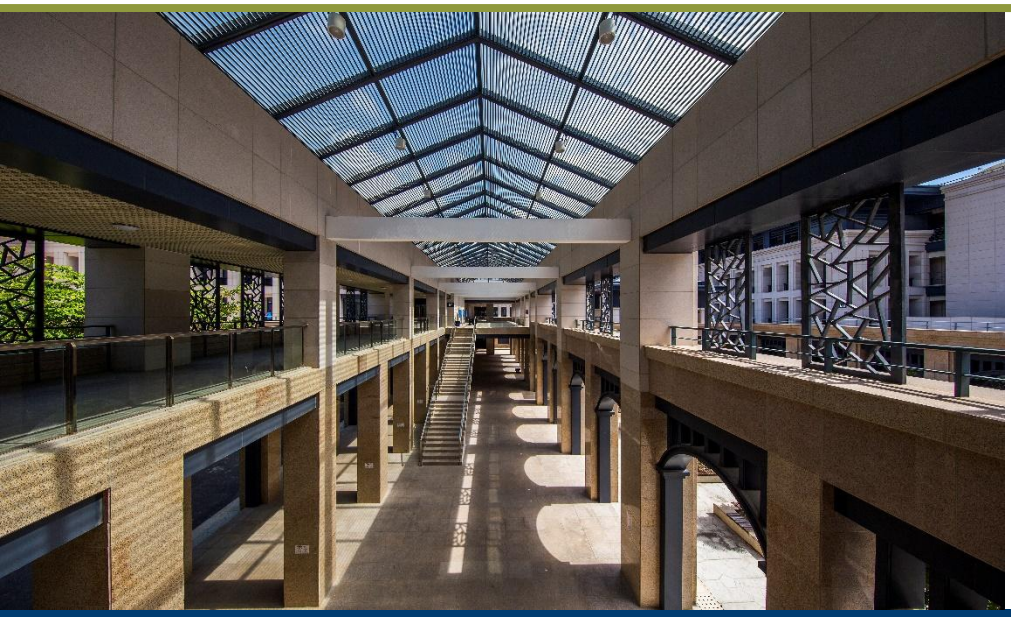

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07 May 2025

✧ Content

❖ Publications (IF≥8, and/or Nature Index; *corresponding author)

1. Bowen Wang, Baowen Wang, Hejin Yan and **Yongqing Cai***. Oxygen vacancy-driven interfacial alloying and mixing for enhanced heat transfer in gallium oxide. *Materials Today Physics*, (2025). DOI: 10.1016/j.mtphys.2025.101714. [2023 IF=10]

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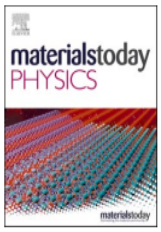

Oxygen vacancy-driven interfacial alloying and mixing for enhanced heat transfer in gallium oxide

Bowen Wang, Baowen Wang, Hejin Yan, Yongqing Cai *

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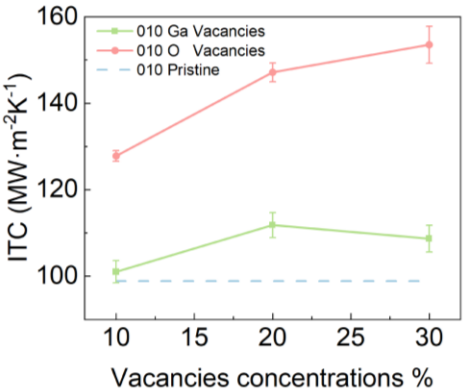
❖ Research Stories

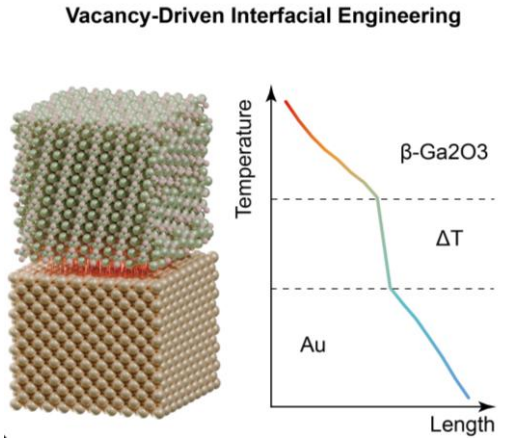
UM research team unveils vacancy-driven interfacial alloying strategy to enhance thermal transport in β-Ga_2O_3/Au heterostructures

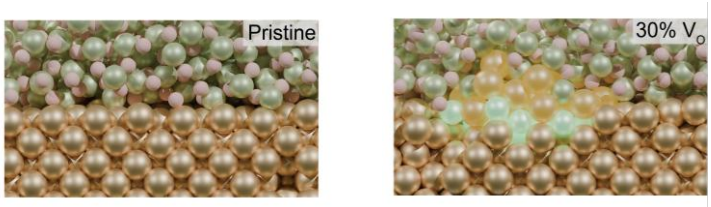
- Efficient heat dissipation remains a key challenge in power electronics. Despite its favorable electronic properties, β-Ga_2O_3 suffers from intrinsically low thermal conductivity and significant interfacial resistance when coupled with metals like Au. Contrary to the conventional emphasis on pristine interfaces, this work demonstrates that controlled introduction of oxygen vacancies (V_O) can enhance interfacial thermal conductance by promoting atomic-scale mixing.
- By combining machine learning-based molecular dynamics with DFT calculations, this study demonstrates that V_O at the β-Ga_2O_3/Au interface act as key drivers of interfacial alloying. V_O facilitate atomic intermixing between Ga and Au, forming an alloy-like transition region that effectively mitigates phonon spectral mismatch. This structural modification enhances phonon coupling, leading to a ~50% increase in interfacial thermal conductance

Mr. Bowen Wang
(王博汶)

Prof. Yongqing Cai
(蔡永青)







Vacancy-driven interfacial alloying strategy

Bowen Wang, Baowen Wang, Hejin Yan and **Yongqing Cai***.
Oxygen vacancy-driven interfacial alloying and mixing for enhanced heat transfer in gallium oxide.
Materials Today Physics, (2025). DOI: 10.1016/j.mtphys.2025.101714. [2023 IF=10]

Prof. Yongqing Cai is the corresponding author of this study. The first author is Mr. Bowen Wang, a Ph.D. student of IAPME. This work was supported by Natural Science Foundation of Guangdong Province, China (2024A1515011161) and the Science and Technology Development Fund from Macau SAR (FDCT-0163/2019/A3, 0085/2023/ITP2, 0120/2023/RIA2). This work was performed in part at the High-Performance Computing Cluster (HPCC), which is supported by Information and Communication Technology Office (ICTO) of the University of Macau.

❖ Seminars

Prof. Huanqing Ye (葉煥青), Dame Kathleen Ollerenshaw Fellow and Assistant Professor at the Photon Science Institute and the Department of Electrical and Electronic Engineering at the University of Manchester, visited IAPME on 16-17 April, 2025. During his visit, he delivered an insightful presentation titled “Molecular rare-earth material systems for the applications of next-generation photonic integrated technologies” . The seminar was hosted by Prof. Handong Sun.

Prof. Ye’s current research interest focuses on the optical characterisation of nanophotonic materials and the development of active photonic integrated devices. He was the senior scientist at Chromosol Ltd, a spin-out company from Queen Mary University of London, from 2018 to 2022, leading the R&D of organic-integrated silicon lasers for photonics 2.0. He worked as a postdoctoral research fellow at Nanyang Technological University in Singapore from 2015 to 2018 and obtained a PhD in Physics at Queen Mary University of London in 2014. He has participated in projects totalling £5M funding from Innovate UK and UK Research Innovation as co-investigators.

During the talk, Prof. Ye first introduced molecular rare-earth materials which uniquely combine the optical properties of rare-earth ions with the processibility of organic materials. This combination enables the development of cable and cost-effective integrated light source technologies. He then presented their research on the correlation between organic vibrational modes, optical transitions and electronic states of rare-earth ions that emit technologically important telecom-compatible near-infrared wavelengths. He also discussed the advantages of organic sensitisation in enhancing the power efficiency of rare-earth-based gain materials, previous R&D of developing integrated on-chip devices, and potential applications of these materials in quantum optics.

During the visit to IAPME, Prof. Ye has exchanged ideas with members of Prof. Handong Sun's group.