THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY | DEPARTMENT OF ELECTRONIC & COMPUTER ENGINEERING

Dear Committee,

At the request of Dr. Qingkai Qian, my previous PhD student in Department of Electronic and Computer Engineering, The Hong Kong University of Science and Technology (HKUST), I am glad to write this recommendation letter for him to apply for the faculty position in your institution. Dr. Qian joined my group in 2014 after receiving his B.S. and M.S degrees from Tsinghua University, CHINA. Over 4 years, I have witnessed Qingkai's development into a mature and independent researcher who is capable of initiating important research topics and completing them with rigorous investigation. He received his PhD in 2018 and joined Prof. Shengxi Huang's group at the Penn State University (USA) as a postdoc to pursue his interests in physics of 2D materials and devices.

At HKUST, Dr. Qian had worked quite independently in my group. His research topic is the investigation of the electronic devices based on 2D materials, mainly focused on MoS2 and WSe2. On the other hand, the majority of my group studied high-frequency and power devices based on wide bandgap semiconductors such as GaN and SiC, which are in a quite different area in terms of research objectives and methodology. With these potential challenges, Dr. Qian managed to initiate his research and quickly mastered the techniques needed for fabricating devices of 2D materials, such as dry transfer, plasma treatment, ALD, and so on. Dr. Qian had shown strong self motivation and excellent experimental skills. He is gifted in critical thinking and independent research. Since van der Waals 2D materials can be conveniently transferred to different target substrates, Qingkai was among the first group of researchers to attempt the heterogeneous integration of MoS_2 and GaN lateral heterojunction FET (i.e. HEMT). A new device structure featuring a semiconducting gate made of MoS_2 and a GaN heterojunction channel was invented and demonstrated. Dr. Qian fabricated the devices of both 2D materials and GaN in this work. The MoS_2 semiconducting gate device maintains the large power delivery capability of the GaN channel, but provides an inherent decoupling between the gate and channel once the channel is turned on, enabling a simple yet effective over-voltage protection. This new device concept offers additional freedom in potential electronic applications. The related work is published on *npj 2D materials and applications*. Dr. Qian had gained abundant knowledge and diversified experimental experiences in 2D and semiconductor materials and devices, a rare combination of expertise among young researchers.

Besides the experiments, Dr. Qian also conducted remarkable works in theoretical analyses. He got his bachelor and master degrees both from Department of Physics in Tsinghua University and had a solid background in both device physics and condensed matter physics. More valuably, he was capable of carrying out theoretical analysis to disclose and engineer the device performances. Based on his in-depth understanding of low-frequency noise, he proficiently used it as a technique to characterize the device stabilities of MoS2 transistors. He also did impressive first-principles calculations based on density-functional theory. For example, he conducted first-principles calculations about the Raman scattering of 2D materials with surface adsorptions and defects, which suggest that *in-situ* Raman spectroscopy can be used to monitor the surface functionalization of 2D materials. He also conducted a quantitative analysis of the layer-dependent second-order Raman scattering intensity of 2D materials, which is published in Physical Review B. Dr. Qian achieved a deep understanding of the fundamental physics, and at the same time, he is aware and capable of using it to meet the engineering demands, which are quite valuable for a young researcher.

After moving to Penn State University as a postdoc, Dr. Qian continued to do research about 2D materials, mainly focusing on optics and quantum photonics. He studied the defect influence over the light emissions of 2D materials, aiming to achieve tunable single-photon emissions. His recent work about the lattice dynamics of van der Waals layered GaTe with laser pulse excitation is quite fundamental and elegant, which is published in ACS Nano. I am confident that he will continue to make significant breakthroughs in his future career.

With solid training in top notch institutions and research groups, Dr. Qian has equipped himself with a profound understanding of both experimental practices and theoretical calculations. He has made important contributions to both fundamental material physics and practical device engineering. Together with his strong sense of critical and creative thinking, he proves himself an excellent scholar. I believe Dr. Qian will become a valuable asset to your institution and I strongly recommend him without reservation.

Sincerely,

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