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New Progress in Optical Signal Enhancement of Chiral Structure

Source: School of Optoelectronic Engineering and Instrumentation Science

In collaboration with Prof. Jiang Weixiang from Southeast University and Prof. Zhang Shuang from University of Birmingham, Prof. Cao Tun of School of Optoelectronic Engineering and Instrumentation Science at DUT has published important research work entitled *Chirality Enhancement Using Fabry–Pérot-Like Cavity* in ***Research***, a cooperative journal of ***Science***.

Chiral molecules that do not superimpose on their mirror images are the foundation of all life forms on earth. Chiral molecules exhibit chiroptical responses, i.e., they have different electromagnetic responses to light of different circular polarizations. However, chiroptical responses in natural materials, such as circular dichroism and optical rotation dispersion, are intrinsically small because the size of a chiral molecule is significantly shorter than the wavelength of electromagnetic wave. Conventional technology for enhancing chiroptical signal entails demanding requirements on precise alignment of the chiral molecules to certain nanostructures, which however only leads to a limited performance. Herein, they show a new approach towards enhancement of chiroptical effects through a Fabry–Pérot (FP) cavity formed by two handedness-preserving metamirrors operating in the GHz region. They experimentally show that the FP cavity resonator can enhance the optical activity of the chiral molecule by an order of magnitude. Their approach may pave the way towards state-of-the-art chiral sensing applications.

Prof. Cao Tun, deputy dean, professor and doctoral supervisor of School of Optoelectronic Engineering and Instrumentation Science. His research team has always been facing the major needs of the country and has been committed to the research of micro-nano components and their applications for a long time.

Research is the official journal of the China Association for Science and Technology (CAST) and is published in collaboration with the American Association for the Advancement of Science (AAAS). Launched in 2018, ***Research*** is the first AAAS/Science Partner Journal, a program that connects respected research institutions to the global scientific community.

RESEARCH ARTICLE

Chirality Enhancement Using Fabry–Like Cavity

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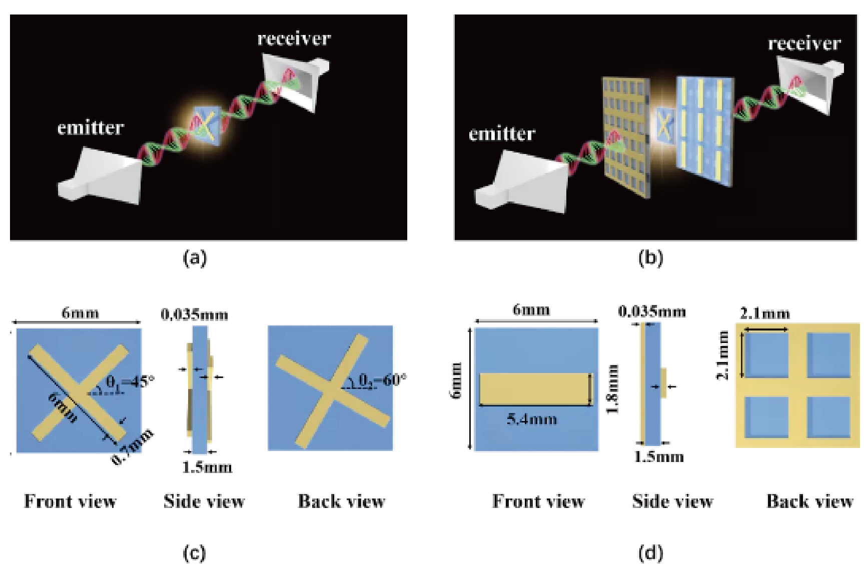


The School of Optoelectronic Engineering and Instrumentation Science of Dalian University of Technology was established in January 2017. It was established by the integration of two first-level disciplines of optical engineering and instrument science to promote the realization of the strategic goal of "Double First-Class" Initiative. The School always faces the frontier of disciplines and the major needs of the country, and is committed to gathering first-class teachers, building first-class disciplines and cultivating first-class talents. At present, the School is in the stage of rapid development, and hereby invites outstanding academic talents and research teams from all levels at home and abroad to join us. For the specific remuneration, please refer to the relevant regulations of DUT or contact dlutoeis@dlut.edu.cn for more information. And the remuneration of high-level talents will be discussed person-by-person.

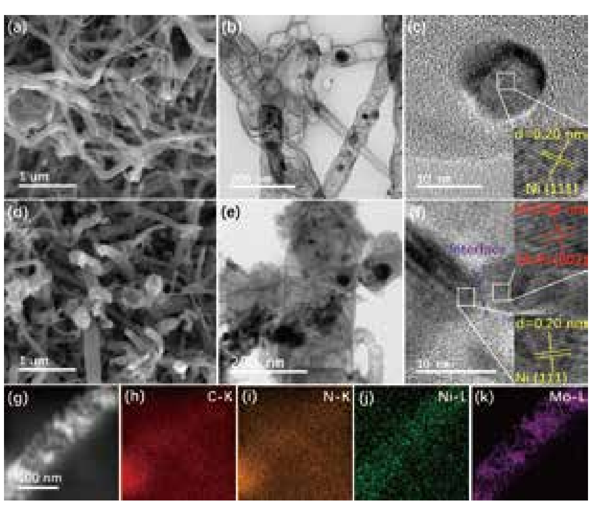
DUT Made Progress in Electrocatalytic Water Splitting Reactions

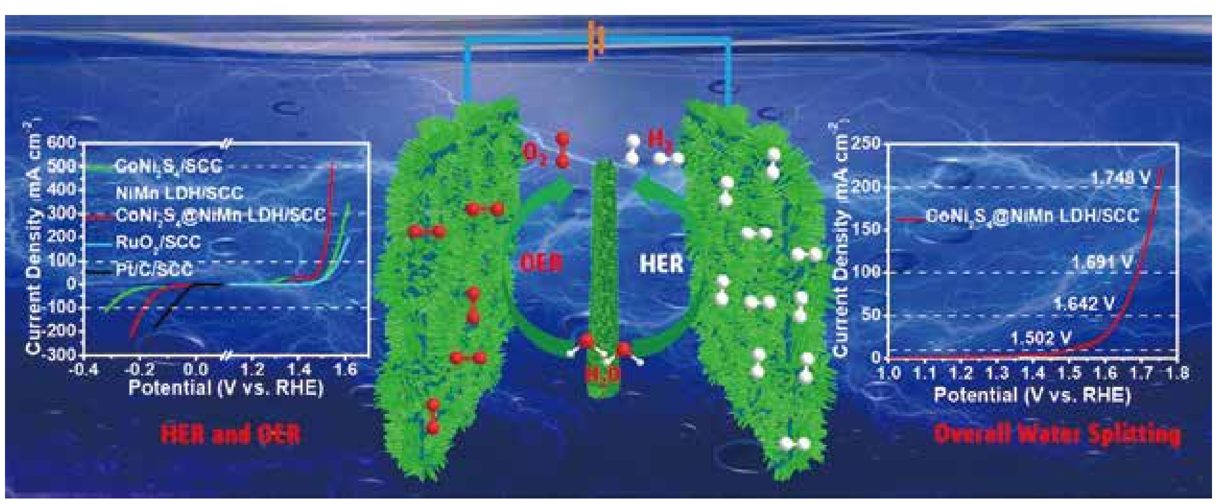
Source: School of Chemical Engineering

Since the rapid consumption of fossil fuels leads to the energy crisis and a series of environmental problems, it is necessary to find efficient, clean and renewable clean fuels, such as hydrogen, to replace non-renewable fossil fuels. As a promising hydrogen production method with high product purity, the electrocatalytic water splitting reaction includes two half-reactions: hydrogen evolution reaction (HER) at the cathode and oxygen evolution reaction (OER) at the anode. However, only under the condition of large overpotential can the high hydrogen production efficiency be achieved, which leads to low energy conversion efficiency and high hydrogen production cost. The development of efficient water splitting catalysts (especially bifunctional catalysts) can effectively reduce the overpotential and improve the energy conversion efficiency. Recently, a team of researchers led by Liang Changhai, a professor from School of Chemical Engineering, DUT, conducted a series of studies on the subject and produced some innovative results, which were published in ***ChemElectroChem, Electrochimica Acta, and ACS Applied Materials & Interfaces.***

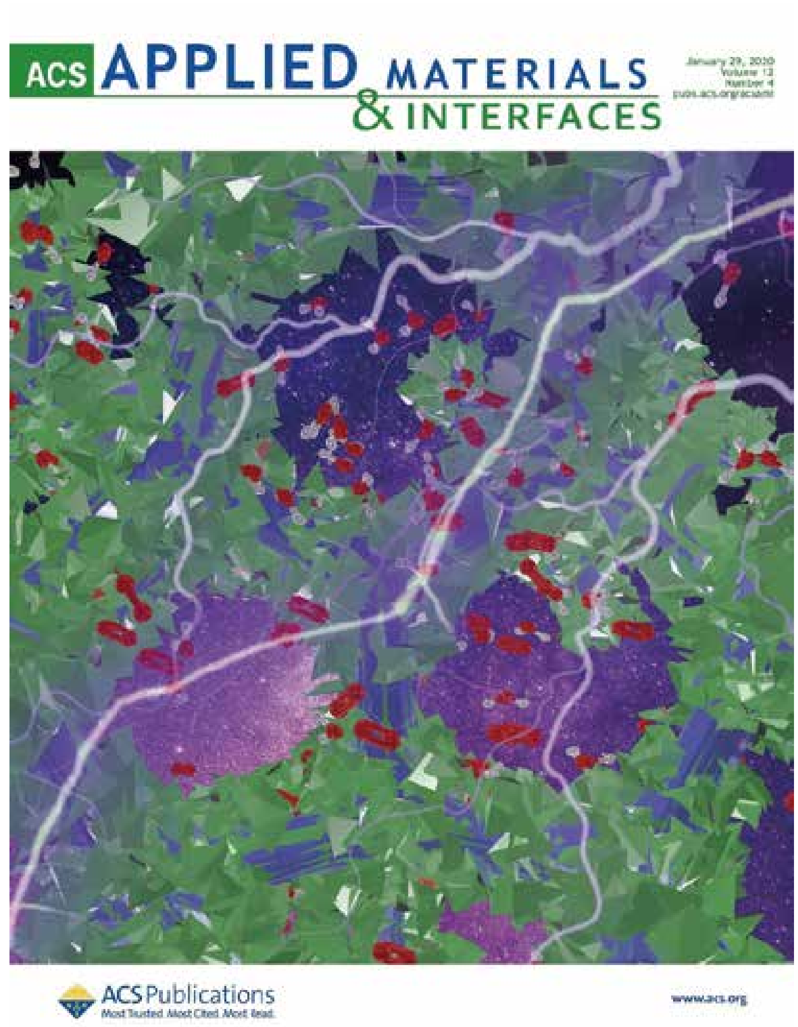
(1) Recently, they found that molybdenum nitride has been widely used as a catalyst for hydrogen evolution due to its catalytic properties similar to those of noble metals (VIII). However, it is still a challenge to improve the catalytic activity and stability of molybdenum nitride. A practical solution is to integrate molybdenum nitride with other functional materials to improve its catalytic performance. Ni-based materials are effective catalysts for OER. The composite of molybdenum nitride and Ni-based materials may improve the activity of the catalyst towards HER and OER. Besides, nano-sized catalysts tend to aggregate and reduce their catalytic activity during stability testing, which can be solved by anchoring or encapsulating them in carbon materials. Based on this assumption, the research team reported a new method for the synthesis of nitrogen-doped carbon nanotubes with Ni/MoN heterostructure on the surface of carbon cloth. Physical characterization and electrochemical test results show that the obtained catalyst has excellent HER, OER and overall water splitting (OWS) performance. This work provides a new strategy to construct a large surface area three-dimensional heterogeneous structure of the water decomposition catalyst. The work was published in the ***ChemElectroChem*** 2020,7,745-752 https://doi.org/10.1002/celc.202000023, entitled "N-doped Carbon Nanotubes Encapsulating Ni/MoN Heterostructures Grown on Carbon Cloth for Overall Water Splitting" .

(2) Then, the research team found that Ni-Co bimetallic sulfides have shown excellent HER properties, but are oxidized at the oxygen evolution anode potential and becomes unstable as a result of sulfur atoms removement from the catalyst. LDH is a kind of OER catalyst with high activity and stability, but its weak conductivity limits its activity. Therefore, when Ni-Co sulfides and LDH are combined, the high conductivity of the former and the high stability of later can be used to compensate their shortcomings to finally achieve high activity towards water splitting. Since it has been reported that Mn can enhance the intrinsic activity of OER by adjusting the electronic structure of FeOOH, NiMn LDH may be a good substitute for the widely used NiFe LDH targeting at higher OER activity. In addition, the electrode can effectively contact the electrolyte as the reactant, which can accelerate the mass transfer and improve the catalytic activity. Based on the above strategies, a hierarchical CoNi2S4@NiMn LDH heterostructure nanowire array was loaded onto a super hydrophilic carbon cloth. The heterostructures of the CoNi2S4@NiMn LDH not only combine the excellent intrinsic activities of the CoNi2S4 nucleus and the NiMn LDH shell, but also compensate their shortcomings and enhance the conductivity and stability. The catalyst shows excellent activity and stability for HER, OER and OWS. For example, when it is used as both cathode and anode in the OWS, achieving current density of 10,50,100 and 200 mA cm–2 requires only 1.502,1.642,1.691 and 1.748 V of applied cell voltage, respectively. Such high activity is competitive among most non-noble metal catalysts at present. The work was published in the ***Electrochimica Acta*** (https://doi.org/10.1016/j.electacta.2020.136247), entitled "Hierarchical CoNi2S4@NiMn-layered double hydroxide heterostructure nanoarrays on superhydrophilic carbon cloth for enhanced overall water splitting".





(3) Based on the previous work, the research team found that the composite catalysts with heterogeneous structures showed stronger catalytic activity than each single component, which is a so-called “1 + 1 > 2” synergistic effect. NiCoP is a known excellent HER catalyst with high conductivity. Moreover, NiMn LDH has shown excellent OER activity and stability. In this context, the research team has designed and synthesized a three dimensional heterostructural water splitting catalyst of NiCoP@NiMn LDH Array, which is supported on nickel foam. As a bifunctional catalyst for OWS, the catalyst has excellent activity: for OER, the current density of 100, 300 and 600 mA cm-2 requires overpotential of 293, 315 and 327 mV, respectively; for HER, it takes only 116,130 and 136 mV of overpotential to reach the current density of 100,200 and 300 mAcm-2, respectively; For OWS, it requires only 1.519, 1.642, 1.671 and 1.687 V applied cell voltage to achieve current density of 10, 100, 200 and 300 mA cm-2, respectively. This excellent activity is superior to the majority of non-precious metal catalysts. Furthermore, for the OWS reaction, the catalyst remains stable for 50h at the current density of 100 mA cm-2 without an obvious decrease in activity. Such high efficiency can be attributed to the following three points: (a) The heterostructures existing between a NiCoP and NiMn LDH not only combine their respective high intrinsic activities, but also produce more active sites and enhance their intrinsic activities through interface effects; (b) The high conductivity of NiCoP enables a fast electron transport channel to enhance the conductivity of the electrode while the nickel foam with three-dimensional network structure can be used as a carrier to expose more active sites and accelerate mass transfer. The work was published in the Journal of ***ACS Applied Materials & Interfaces 2020***, 12, 4385-4395 (https://doi.org/10.1021/acsami.9b15208), and featured as a cover story entitled “Three-Dimensional Heterostructured NiCoP@NiMn-Layered Double Hydroxide Arrays Supported on Ni Foam as a Bifunctional Electrocatalyst for Overall Water Splitting”.



This work was supported by the National Natural Science Foundation of China (21373038 and 21703028), the China Postdoctoral Science Foundation (2018M630290) and the Fundamental Research Funds for the Central Universities (DUT18RC(4) 042 and DUT16RC(3)053). The first author is Wang Pan, a 2016 doctoral student from School of Chemical, DUT. The corresponding author is Professor Liang, Changhai from School of Chemical Engineering, DUT. At present, the main research areas of Professor Liang’s team include heterogeneous catalytic synthesis of fine chemicals; efficient and clean conversion of unconventional resources to fuels and chemicals; environmental catalysis (catalytic combustion of VOC, co-denitrification and mercury removal); electrocatalytic energy storage and conversion.

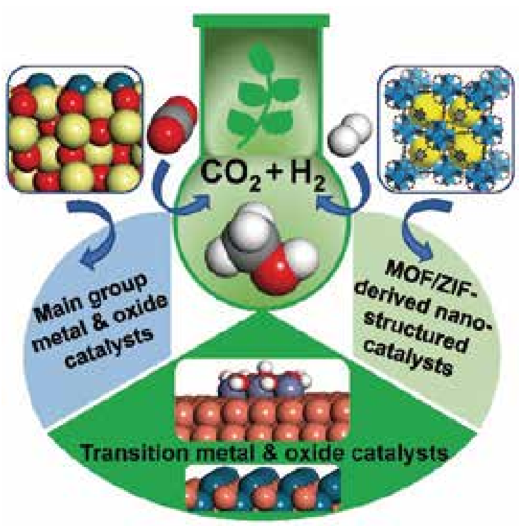
DUT Made Progress in CO2 Catalytic Conversion

Source: School of Chemical Engineering

Recently, in collaboration with Dr. Xiao Jiang from Georgia Institute of Technology, Prof. Thomas P. Senftle from Rice University, Prof. Chunshan Song from Pennsylvania State University, and Prof. Jingguang Chen from Columbia University, Prof. Xinwen Guo's research team of School of Chemical Engineering at DUT has made great progress in CO2 catalytic conversion and produced a series of innovative results. Representative achievements are published in top international journals of Chemistry and Catalysis: Chemical Reviews, Advances in Catalysis, Journal of Catalysis, and ACS Catalysis.

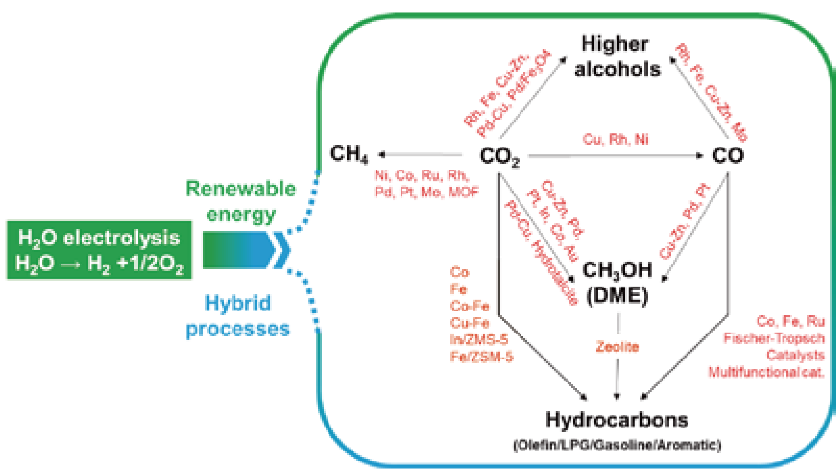
(1) Review on CO2 Hydrogenation to Methanol

Recently, Prof. Xinwen Guo's research team at DUT and collaborators contributed an important review on the importance of catalyst performance, catalyst structure-activity relationship, understanding reaction mechanism, and determining key calculation parameters for designing efficient catalysts in CO2 hydrogenation to methanol. This paper has been published in Chemical Reviews (https://doi.org/10.1021/acs.chemrev.9b00723).



(2) Review on CO2 Hydrogenation to Alcohols and Hydrocarbons

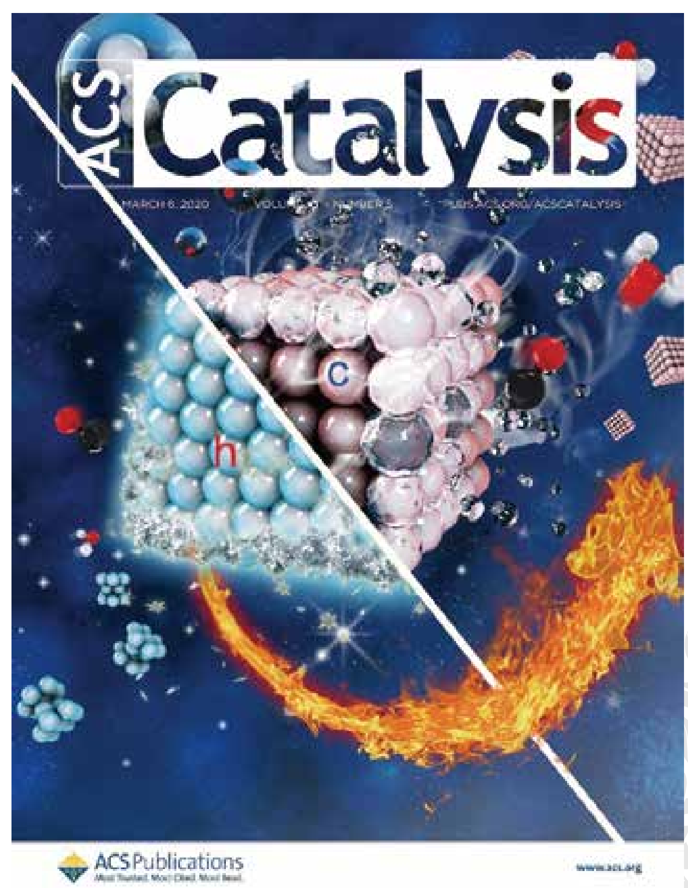
Based on the research achievements of metal-based catalysts in the past decade, Prof. Xinwen Guo's team at DUT and collaborators reviewed the research progress of heterogeneous catalytic CO2 hydrogenation to alcohols and hydrocarbons. Recent studies on key factors affecting the activity and selectivity of CO2 conversion, such as metal type, support, catalyst composition, and the understanding of structure-activity relationship between reaction pathways and catalysts are systematically reviewed. This paper has been published in Advances in Catalysis (2019, 65, 121–233).



(3) Research Progress in CO2 Catalytic Conversion

Indium oxide (In2O3) based catalyst exhibits excellent performance in catalytic hydrogenation of CO2 to methanol. Recently, Prof. Xinwen Guo's team at DUT and collaborators revealed the key role of water in methanol synthesis by combining the catalytic experiments with density functional theory (DFT) calculations. This work provides new insight and research basis for understanding the mechanism of how the addition of extra H2O can promote the conversion of CO2 to CH3OH by tuning the surface structure and property of In2O3/ZrO2 catalyst. The interesting results have been published in Journal of Catalysis (2020, 383, 283–296).

Understanding the structure-catalytic activity relationship is crucial for developing novel and efficient catalysts with desired performance. Recently, Prof. Xinwen Guo's research team at DUT and collaborators reported the importance of the crystal phase of In2O3 catalyst in the reaction of reverse water gas shift (RWGS) by using the methods of catalytic experiment and DFT calculation, providing new insight for the understanding and design of efficient RWGS catalysts. This work has been published in the cover of ACS Catalysis (2020, 10, 5, 3264-3273).



DLI Boosts Academic Support During the Pandemic

Source: Leicester International Institute, DUT

To implement the requirement of "Ensuring learning insusceptible when universities are closed", explore new ideas and new methods to promote rigorous academic atmosphere during this pandemic and provide high-level ideological guidance for students, Dalian Leicester Institute has been taking multiple actions simultaneously to promote the academic atmosphere steadily during the outbreak by improving the co-cultivation between family and school, motivating students' learning initiative and enhancing the exemplary effect of the student leads, etc.

Coherent education by home-school collaboration.

Student tutors regularly communicate with students who had academic difficulties and their parents online, establishing a home-school linkage mechanism to know about students' learning progression, provide adequate guidance, and ensure that every student is supported.

Enhancing learning efficiency by improving self-discipline.

Since February 28, DLI has carried out the activity of "morning reading and morning learning". Senior students read academic articles to enhance their professional knowledge and year 1 students memorize English vocabularies to improve their English foundation. Therefore, students can quickly adapt to the pace of daily online classes, and enhance their self-discipline awareness.

Supervising the whole process and strengthening the learning consciousness.

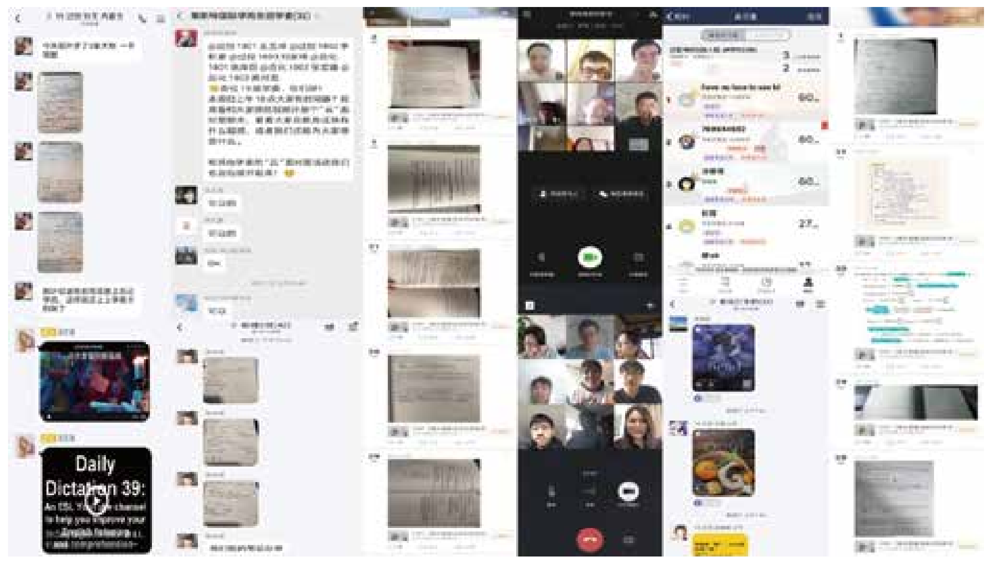
Each class holds regular class meeting, aiming to make a study plan and target for this semester in light of the academic performance of the autumn term so as to create a positive competitive academic atmosphere and stimulate students' online study motivation. A series of activities have been held, such as online self-study room, English speaking activity, reading salon, notes checking, resources sharing, etc. Besides, DLI has been holding feedback meetings to know about students' opinions and suggestions toward online teaching and online learning in order to solve students' problems and optimize students' experience promptly.

Broadening online learning channels by cloud sharing.

The WeChat official platform of DLI has been releasing a series of learning resources, which covers recommends professional books, English learning skills, soft wares usage, career development, etc. which has broadened and enriched students' knowledge. It has also published many notifications and information about academic competitions and activities to help students make a full preparation in advance.

Stimulating interests & improving professional skills.

DLI is organising four sessions of "The Narrator" English speaking contest which not only to enhance the English speaking level of the contestants but also to help the listeners accumulate English knowledge and improve the listening ability. Besides, The Student Union of Panjin campus and DLI also collaboratively held an IELTS and TOEFL mock exam, which helped students have a better understanding of their



English level and make a clearer plans for future study.

Student leads play an exemplary role.

DLI held learning experience sharing sessions which invited outstanding students from each programme and each class to share their learning experiences and skills. Moreover, DLI also held science and technology innovation salons, invited students to share related experiences aiming to improving students' enthusiasm to participate in the scientific and technological innovation competitions and projects. In addition, DLI is implementing peer support activities, such as organising online sessions for the students with good academic performance help with the comparably weak students by going through the lectures and answering questions to create a positive routine of mutual help.

During this unprecedented epidemic, DLI has been attaching great importance to the construction of learning, motivating students to fulfil the study schedule with high quality, and improving students' independence of self-learning. DLI will keep working on the development of academic construction to ensure the high standard of online teaching and high effectiveness of online learning.