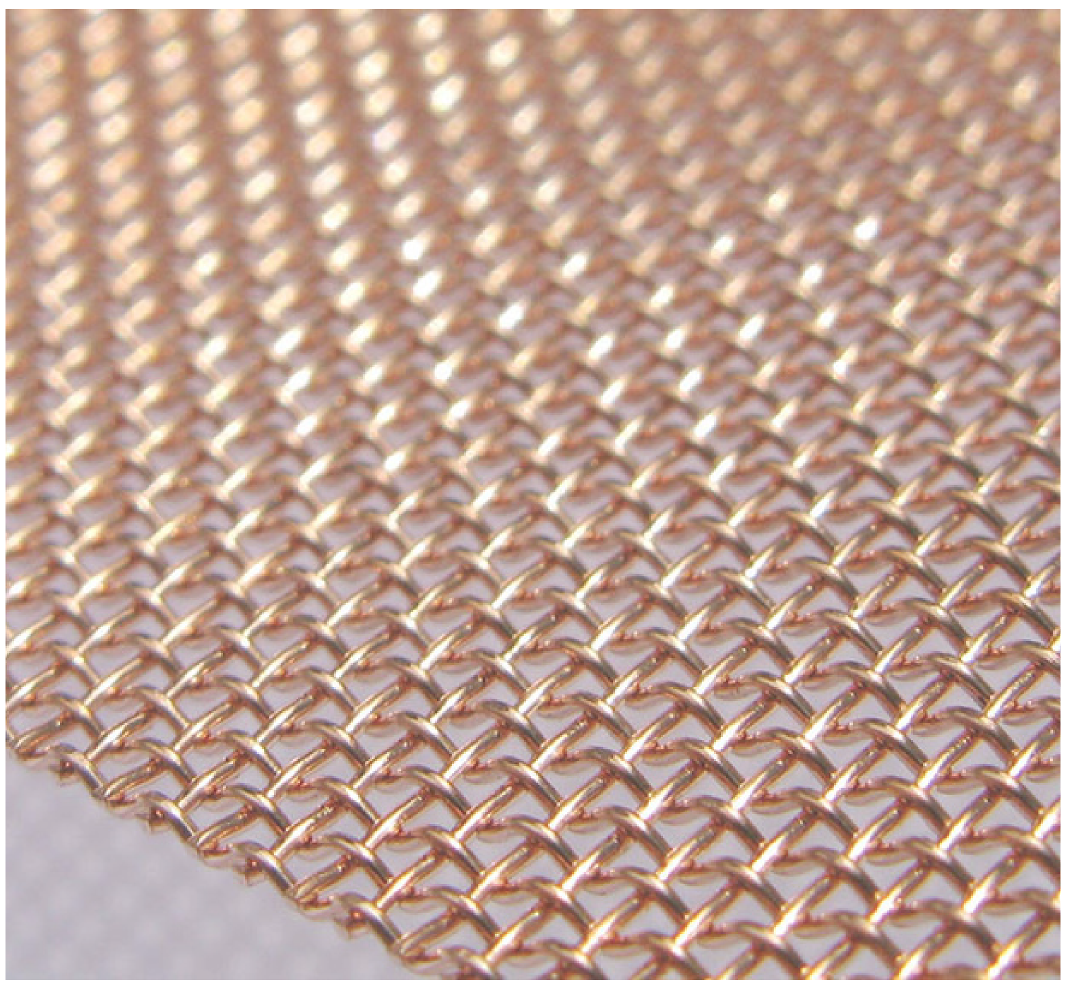
# 2022

## HK Tech Forum
## City university of Hong Kong



# Forum on Advanced Matter and Materials

## Programme Booklet

香港城市大學
City University of Hong Kong

HK TECH FORUM

香港城市大學
City University of Hong Kong

Hong Kong Institute for Advanced Study

Department of Materials Science and Engineering
香港城市大學
City University of Hong Kong

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# ABSTRACT (DAY 1)

Prof. Ke LU
Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences
Liaoning Academy of Materials

## The Schwarz crystal structure: A metastable structure in polycrystalline metals with extremely fine grains

Abstract: Metals usually exist in form of polycrystalline solids with crystalline grains separated by networks of grain boundaries (GBs) that are structurally disordered. The GBs are unstable and tend to get eliminated through grain coarsening upon heating or straining, or to transform into metastable amorphous states when the grains are extremely fine. This is why nano-grained metals have a much reduced stability relative to their coarse-grained counterparts, which is the major bottleneck limiting their processing and technological applications. Through experiments and MD simulations, we recently discovered a novel metastable state for extremely fine-grained metals (typically below 10 nm), namely Schwarz crystal structure. The GB-network of the metal is characterized by 3D minimal interfaces structure (with a zero-mean-curvature) constrained by twin boundaries. The unique structure is thermally stable against grain coarsening even close to the equilibrium melting point and exhibits a hardness in vicinity of the theoretical value. The across-boundary diffusion is so effectively suppressed that the diffusion-controlled processes such as intermetallic precipitation are inhibited. In this presentation, I will introduce the formation process, structure characteristics, and some properties of the Schwarz crystal structures in a number of pure metals and alloys.

1. X.Y. Li, Z.H. Jin, X. Zhou, K. Lu, Science, 370, 831-836 (2020).
2. W. Xu, B. Zhang, X.Y. Li, K. Lu, Science, 373, 683-687 (2021).
3. Z.H. Jin, X.Y. Li, K. Lu, PRL, 127, 136101 (2021).

Moderator: Prof. King-Ning TU, City University of Hong Kong

Prof. Nikolaus OSTERRIEDER
City University of Hong Kong

## Vaccine or treatment: No Entry of SARS-CoV-2 is the goal

Abstract: Blocking of viruses at the portal of entry is an extremely attractive approach to combat infections and for pandemic preparedness. We have explored various strategies for the inhibition of viruses at mucosal surfaces, particularly in the oronasal cavity. Our work has focused on carbon-based architectures, especially graphene and its derivatives. One of the major problems in the development of novel virus inhibitor systems is the adaption of the inhibitor to the size of virus particles, and we synthesized and tested carbon-based inhibitors of different sizes to evaluate potential size effects on the inhibition of virus entry and replication. Nanomaterials were functionalized with polygylcerol through a "grafting from" polymerization to form new polyvalent nanoarchitectures, which allowed polysulfation to mimic the heparan sulfates present on cell surfaces that we reasoned would compete with the binding sites of herpes viruses. Inhibitory efficiency is regulated by the size of the polymeric nanomaterials and the degree of sulfation and the derivatives inhibited virus infection at an early stage as predicted. In similar work, inhibition of SARS-CoV-2 by graphene platforms with precise dual sulfate/alkyl functionalities was investigated. A series of graphene derivatives with different lengths of aliphatic chains were synthesized and we showed that graphene derivatives with long alkyl chains (>C9) inhibit coronavirus replication by virtue of disrupting viral envelope.

Moderator: Prof. King-Ning TU, City University of Hong Kong

# ABSTRACT (DAY 1)

Prof. Lit Man Leo POON
The University of Hong Kong

## Stability of SARS-CoV-2 in different environmental conditions

Abstract: SARS-CoV-2, a novel coronavirus, was emerged in humans in 2019. The virus has been quickly transmitted around the world in weeks and led to the declaration of COVID-19 pandemic by WHO in March 2020. In the initial stage of the COVID-19 outbreak, there was very limited understanding about the novel pathogen. Epidemiological studies indicate that COVID-19 majorly spread via the droplet transmission route between people in close contact. However, the disease is also possible to transmit via the indirect contact route, i.e. a person becomes infected when touching their eye, nose or mouth after touching a virus-contaminated surface or object. In addition, there are evidences that facilities occupied by COVID-19 patients are heavily contaminated with SARS-CoV-2. In order to better understand the modes of transmission of COVID-19 in human populations, knowledge related to physical or environmental parameters that can control the stability and transmissibility of SARS-CoV-2 is warranted. In this seminar, we will discuss the stability of SARS-CoV-2 in different environmental conditions. The effects of commonly used disinfectants on the virus and protocols for disinfecting virus-contaminated surfaces will also be studied. In addition, we will also discuss the virucidal effects of different metallic surfaces. These findings can help to develop approaches for inactivating SARS-CoV-2 in environmental surfaces, thereby reducing the risk of fomite transmission.

Moderator: Prof. Nikolaus OSTERRIEDER, City University of Hong Kong

Dr. Ruquan YE
City University of Hong Kong

## Laser-induced graphene for rapid and efficient disinfections

Abstract:  The prevalence of COVID-19 has caused global dysfunction in public health, sustainability, and socio-economy. While vaccination shows potential in containing the spread, the virus variants and co-infection with other diseases such as fatal fungal infections and monkeypox have further exacerbated the scenario. Therefore, the development of surfaces showing broad-spectrum antiviral and antimicrobial activities is imperative, especially amid the early stage of an unknown pandemic.

In this presentation, we will introduce our recent development of laser-induced graphene (LIG) technology for fighting against disease transmission. We will start with the introduction of LIG, a revolutionary technique to synthesize porous graphene film from universal carbon precursors. Then we will focus on our strategies for surface engineering of LIG, which enable rapid and efficient disinfection under mild conditions. The intrinsic, photothermally and electrically enhanced antimicrobial and antiviral activities of different types of LIG will be discussed. Lastly, we will showcase other developments of the LIG techniques and highlight their impacts on the environment, including surface sensing via hygroelectricity, degradation via Joule-heating, and water disinfection via electrochemistry.

Moderator: Prof. Nikolaus OSTERRIEDER, City University of Hong Kong

# ABSTRACT (DAY 1)

Dr. Yingxia LIU
City University of Hong Kong

## The design of copper microstructure for the fast killing of virus

Abstract: The pandemic of coronavirus SARS-COV-2 leads us to the question of how to make human society more reliable under the strike of virus. The virus with a high spontaneous mutation rate challenges the cognitive process and the development of antiviral agents. The killing of virus and bacteria on copper surfaces is known, and the mechanism is explained as copper ions released from a copper surface. On an ordinary copper surface, it will take a few hours to kill the virus. In this talk, we try to enhance the virus-killing reaction rate by the design of copper surface microstructure. We made a copper surface by depositing (111)–oriented nanotwin and studied the killing effect of Feline Infectious Peritonitis Virus (FIPV). By making clear the chemistry and physics mechanism behind virus killing on copper surfaces, we will try to increase the virus-killing rate further. In the future, we can make a copper filter for air quality control in public buildings, for example, the filter can be installed in the ventilation system, on the ceiling of restaurants, or in other common places to purify the air and prevent the spread of the contaminated air. We can also make recyclable copper masks for individual people.

Moderator: Prof. Nikolaus OSTERRIEDER, City University of Hong Kong

Dr. Douglas YU
Taiwan Semiconductor Manufacturing Company (TSMC)

## Implementation of Advanced Materials for Semiconductor Technologies

Abstract: Semiconductor technology migration has followed Moore’s Law in chip scaling for around 60 years. Along those years, advanced materials have been introduced to enable chip (system-on-chip, SoC) scaling and provide performance, power efficiency and area/size values. When it becomes more challenging to continue Moore’s Law, wafer-level-system integration technologies, such as 2.5D and 3DIC have emerged to achieve system-on-package (SoP) scaling to enable system-level performance, power efficiency and size/volume values. System integration of chiplets is complementary to SoC scaling and support Moore’s Law extension. Advanced materials are also introduced in the packaging to realize the SoP scaling.

The implementation of new and advanced materials often introduces various kind of processing and integration challenges to be addressed. In this presentation, we will review some examples of introducing advanced materials in both SoC and SoP on their challenges and the approaches to resolve those issues. Looking forward, we would like to continue supply chain collaboration, innovation and leverage existing resources and capabilities to introduce more advanced materials to continue SoC- and SoP-Scaling.

Moderator: Dr. Yingxia LIU, City University of Hong Kong

# ABSTRACT (DAY 1)

### Prof. Chih CHEN

National Yang Ming Chiao Tung University
National Chiao Tung University

## Cu-to-Cu direct bonding and hybrid bonding

Abstract: Cu-to-Cu direct bonding has been implemented in high-end microelectronic devices with ultra-high input/output (I/O) density. The pitch of the Cu-Cu joints can be scaled below 1 mm, and thus its I/O density can be 300 times larger than that of the solder microbumps. In this presentation, the fundamental mechanism and interfacial microstructures of Cu-Cu direct bonding will be presented. A creep bonding model will be proposed. Then Cu/SiO2 hybrid bonding will be introduced. We adopted (111)-oriented Cu with high surface diffusivity to achieve low-temperature and low-pressure Cu/SiO2 hybrid bonding. The bonding temperature can be lowered from 300 °C to 200 °C, and the pressure is as low as 1.06 MPa. The bonding process can be accomplished by a 12-inch wafer-to-wafer or die-to-die scheme. The measured specific contact resistance is 1.2x10$^{-9}$ Ω·cm$^{2}$, which is the lowest value reported in literature for Cu-Cu joints bonded below 300 °C. The joints possess excellent electric properties up to 375 °C. Reliabilities of the Cu-Cu joints will be also presented.

Moderator: Dr. Yingxia LIU, City University of Hong Kong

### Prof. Yi-Chia CHOU

National Taiwan University

## Point contact reaction for silicide formation in Si nanowires

Abstract: Many electronic devices, such as field-effect transistors, depend on achieving precise control of both a semiconductor nanostructure and its contact with the larger scale circuit. The control of the contact between nanowire and circuit is a key step that involves integrating different types of materials and bridging between length scales. In Si nanowires, we show that silicide formation can occur through a point contact reaction and we demonstrate that the reaction shows different kinetics from those already known in thin filmsilicide technology. We discuss the strain effect on the nucleation and growth of silicides in nanowires with thermodynamic, kinetic, and strain energy implications. Such nanowires have an oxidized surface and this controls the reaction pathway and kinetics. To follow up the present model, the gradient of stress potential is treated as the driving force for “uphill diffusion” of metal atoms in Si to migrate to the epitaxial interface. Additionally, the strain effect is taken as a reason that an extremely high degree of supersaturation of Ni, over a factor of 1000 needed for NiSi formation, can take place near the interface. The need of an extremely high super-saturation, about a factor of 1000, of Ni interstitials for the nucleation is because of the extremely low equilibrium solubility of Ni in Si. Also what is the diameter of the point contact is irrelevant, provided that it is not closed to stop the reaction.

Moderator: Dr. Yingxia LIU, City University of Hong Kong

# ABSTRACT (DAY 1)

**Prof. Andriy M. GUSAK**
Cherkasy National University
Centre of Excellence "Ensemble3"

## New thermodynamic approaches to failure analysis in microelectronic materials

Abstract: Failure of the microelectronic device may be treated in the frame of non-equilibrium thermodynamics. Three main ideas are discussed:

Failure may be treated as a result of accumulation of structural entropy beyond some threshold value. Accumulation of structural entropy is calculated as a "non-heating" part of entropy production in the processes of electromigration, thermomigration and stress migration. Such approach leads to the Black's equation for MTTF with exponent n=2 for electromigration-induced failure, and to analogous predictions for thermomigration-induced failure, as well as for stress migration-induced failure.

Failure may be treated as a kind of the first-order phase transformation in an open system, and includes nucleation, growth or migration and (sometimes) ripening. Moreover, the usually used cumulative Weibull distribution for time to failure (TTF) looks very similar to Kolmogorov-Avrami equation for crystallization kinetics describing nucleation and growth of crystalline phase [1]. Several examples of failure mechanisms are analyzed within this framework.

Failure may be treated as a result of incompatibility of steady-states for different processes in an open system. For example, steady-state current under fixed voltage between the cathode and anode ends of interconnect leads to electromigration of atoms and vacancies which, in realistic materials, lead to non-steady-state voiding and hillock formation, and to eventual failure. Fully compatible steady-states for all processes would mean "immortality" at least for interconnect.

1. TU, King-Ning. *Electronic thin-film reliability*. Cambridge University Press, 2010.

Moderator: Prof. Shien Ping FENG, City University of Hong Kong

**Prof. Xinping QU**
Fudan University

## Wet processes deposition for HAR TSV metallization using electroless Co liner and alkaline Cu seed layer

Abstract: Three-dimension (3D) integration with TSV technology has been regarded as a promising way to overcome the limitation of Moore's law. The conventional physical vapor deposition (PVD) has shown difficulty in depositing the conformal barrier/liner and Cu seed layer in high aspect ratio (HAR) TSV. Other alternative methods such as chemical vapor deposition (CVD) and atomic layer deposition (ALD) are both based on the high-temperature and high-cost process to obtain the conformal film. Electroless deposition (ELD) technology is a robust candidate to replace the PVD in the HAR TSV metallization owing to its advantages of conformal film coverage and low cost. Co has been considered as an excellent liner material because of its better wettability with Cu and lower resistivity than Ta. The application of the ELD pure Co layer in TSV has not been reported. In this presentation, we demonstrated a wet processes flow for HAR TSV metallization. The ELD Co liner and alkaline electroplating deposited Cu seed layer are successfully integrated into a 4 μm × 50 μm TSV. The ELD Co film can have a low resistivity of 13.6 μΩ·cm, due to high metallic Co purity of about 99.4%. The Co liner layer with a step coverage of up to 98% is formed on the TiN barrier in the TSV followed by a conformal alkaline Cu seed layer with step coverage of 75%. Finally, the TSV is filled without voids by the acidic Cu electroplating. This work demonstrates the feasibility of the wet processes flow of conformal liner and seed layer in the HAR TSV.

Moderator: Prof. Shien Ping FENG, City University of Hong Kong

# ABSTRACT (DAY 1)

Prof. King-Ning TU
City University of Hong Kong

## Low Entropy Electronic Packaging Centre in City U, HK

Abstract: Low entropy means low waste heat, for processes which use low temperature and low electrical current density. In the beginning, the Centre will focus on reliability issues in 3D IC due to Joule heating as well as heat dissipation. Specifically, electromigration, thermo-migration, and stress-migration failures will be analysed. Three examples are given below. First, based on Onsager's theoretical study of entropy production, we can perform 1T1j (one temperature and one current density) rather than 3T3j to obtain the statistical distribution of mean-time-to-failure of a device. Furthermore, we can calculate $I_{max}$. Second, we developed experimentally the room temperature solid-state solder joint formation. It is different from the conventional solid-liquid interfacial diffusion (SLID) based solder joint formation at 250 °C. Third, we perform low temperature Cu-to-Cu and hybrid bonding. In the long run, the link between semiconductor technology and bio-medical applications will be emphasized. Our cut-in point is to use Cu cloth and (111) oriented nano-twin Cu to inactivate COVID-19 virus.

Moderator: Prof. Shien Ping FENG, City University of Hong Kong

# ABSTRACT (DAY 2)

Prof. Zhaoping LU
University of Science and Technology Beijing

## Developing advanced high-performance metallic materials via engineering coherent nanostructures

Abstract: Advanced metallic materials with ultrahigh strength and large damage tolerance are urgently required in the field of aerospace, advanced transportation and nuclear energy where materials have to be exposed to most challenging environments, including extreme loading, temperatures and irradiations. However, simultaneously improving the strength and damage tolerance of the structural materialsis is extremely difficult due to the fact that the hardening media for increasing strength usually weakens the damage tolerance under various environments, especially in the ultrahigh-strength regime. In our work, a novel alloy design strategy was proposed to develop advanced high-performance metallic materials through the formation of coherent nanostructures, which interact with other crystal defects, such as dislocations, grain boundaries and irradiation defects, in an exceptional fashion. As a result, the long-standing tradeoff between the strength and damage tolerance was solved and a new grade of ultrahigh strength materials including steels and refractory high-entropy alloys with prominent mechanical properties and radiation tolerance were developed via tailoring the ordered nanostructures in different alloy matrices. The involved alloy design strategy and the underlying mechanisms responsible for the outstanding properties and unique performance behaviors will be discussed in detail.

Moderator: Prof. Chain-Tsuan LIU, City University of Hong Kong

Prof. Peter K. Liaw
The University of Tennesse

## Advanced high-entropy alloys design and fundamental understanding aided by neutron scattering*

Abstract: Recently, exceptional properties that are continuously found in an intriguing new class of metallic structural materials, high-entropy alloys (HEAs), demonstrate their great potential for engineering applications particularly in extreme environments where conventional alloys reach their limits. The concept of HEAs has revolutionized traditional alloy design, in particular in terms of their endless composition space, which meanwhile brings a new challenge of how to effectively design HEAs with targeted properties. In this presentation, we will give an introduction on HEAs first. Following that, we will focus on the design of advanced precipitate-strengthened lightweight HEAs for high-temperature applications by integrating computational methods and advanced experimental techniques, such as neutron scattering. We will discuss how to design high-strength, low-cost, and lightweight HEAs by the Calculation of Phase Diagrams (CALPHAD)-based high-throughput computational method (HTCM). A fundamental understanding of the precipitation-strengthening and order-disorder-transition behaviors in these newly-designed lightweight HEAs is revealed by *in-situ* neutron scattering, advanced microscopies, Monte-Carlo (MC) simulations, and *ab initio* molecular dynamics (AIMD). This study provides in-depth insights into the discovery of advanced structural materials by the HEA concept.

*R. Feng, C. Zhang, M.C. Gao, Z. Pei, F. Zhang, Y. Chen, D. Ma, K. An, J.D. Poplawsky, L. Ouyang, Y. Ren, J.A. Hawk, M. Widom, P.K. Liaw, High-throughput design of high-performance lightweight high-entropy alloys, Nature Communications 12(1) (2021) 4329.

Moderator: Prof. Chain-Tsuan LIU, City University of Hong Kong

# ABSTRACT (DAY 2)

Prof. Yong LIU
Central South University

## Design and strengthening mechanism of Ti metal-metal composite (MMC) with heterogeneous structures

Abstract: Metal-metal composite (MMC) is a typical heterogeneous material that consists of metal matrix and secondary metallic phase. Due to the compositional gradient interface, MMCs usually have a better combination of strength and ductility compared with conventional ceramic reinforced composites. However, the effecting mechanism of gradient interface on mechanical behavior of MMCs is still unclear. In this study, we proposed a powder metallurgical method to prepare titanium matrix MMCs, such as Ti-Ta, Ti-Mo and Ti-W composites. A superior combination of tensile strength (1200~1500 MPa) and elongation (8~20%) was achieved. It was found that the structural gradient interface, produced by the compositional gradient, could generate strong hetero-deformation induced (HDI) stress, which consequently enhanced the strength of the MMCs. Meanwhile, multiple deformation modes including dislocation planar sliding, stress-induced twining (TWIP), and stress-induced martensite phase transformation (TRIP) were activated around the gradient interface during plastic deformation, which help to release stress concentration and increase strain hardening capability, thereby resulting in a good ductility. Moreover, the mechanical behavior of Ti-metal composites under high strain rates were also reported. Besides, we have proposed a new interface stress model to evaluate the HDI stress from the perspective of residual strain energy. The HDI stress values obtained from the new interface stress model can more reasonably explain the interfacial strengthening effects than those from the well-used back stress model for heterogeneous-structured materials.

Moderator: Prof. Xun-Li WANG, City University of Hong Kong

Prof. Mingxin HUANG
The University of Hong Kong

## Revisit TWIP and TRIP effects on strain hardening of high-strength steels

Abstract: High strength steels are widely used in various industries. Understanding the strain hardening mechanism of high strength steel plays a key role on the development of new class of high strength steel. The first part of the present work revisit the twinning-induced plasticity (TWIP) effect on the strain hardening mechanism of TWIP steel. It is found that TWIP effect has trivial effect on the strain hardening of TWIP steel. Instead, carbon-induced high dislocation in TWIP steel is the major mechanism responsible for the high strain hardening of TWIP steels. The second part revisit the TRIP effect on strain hardening of TRIP-assisted steels at high-strain-rate deformation. During high-strain-rate deformation, martensitic transformation does occur, but the strain hardening rate is still low, indicating that TRIP effect does not provide strain hardening behaviour at high-strain rate. Further investigation indicates that the reason for this abnormal TRIP effect at high strain rate could be attribute to the critical role of interstitial carbon played in the TRIP effect.

Moderator: Prof. Xun-Li WANG, City University of Hong Kong

# ABSTRACT (DAY 2)

Prof. Yong YANG
City University of Hong Kong

## Multi-Functional High Entropy Alloys with Heterogeneous Lattice Strain

Abstract:  High entropy alloys have been recently attracted tremendous research interest worldwide because of their excellent mechanical, chemical and physical properties. In this talk, I would like to discuss our recent work that aims to address some fundamental questions in this field, such as entropic design of alloys and lattice distortion. Through extensive experiments and simulations, we are able to show that it is possible to develop multi-functional high entropy alloys by carefully mixing elements of distinct sizes, which could exhibit a combination of unique mechanical/physical properties, such as superb strength, excellent elastic strain limit, ultralow mechanical hysteresis, remarkable elinvar effect, superior plasticity and many others.  At the fundamental level, we found that the multi-functionality of these high order alloys could be attributed to not only chemical fluctuations, but also the presence of heterogeneous lattice strains, both of which however are lacking in conventional alloys.

Moderator: Prof. Xun-Li WANG, City University of Hong Kong

Prof. Jien-Wei YEH
National Tsing Hua University

## High-entropy materials technology

Abstract: “High-Entropy Materials (HEMs)” has become an emerging field through the collective efforts of many researchers in the last two decades. Such materials were revolutionary because they were historically thought to be difficult or even impossible to be fabricated and applicable due to their brittleness by nature. High entropy effect which was ignored before has become well-known to enhance the formation of multielement solution phases and avoid complicated microstructure with complex phases. As the long-standing bottlenecks of conventional materials were difficult to be solved by conventional materials concept, HEMs thinking will increase the whole materials ability to solve the conventional bottlenecks. Various categories of materials with high entropy effect have been developed, which indeed display promising properties for different applications. It is the time to build HEMs technology which could transfer those promising discoveries into industrial production and thus create well-being for our society. In this presentation, the main bottlenecks in conventional materials and the ESG issues in energy, waste, pollution, natural resource conservation are pointed out to emphasize the large opportunities of HEMs and related materials. Some industrialized examples of high-entropy materials technology are also presented.

Moderator: Prof. Ji-Jung KAI, City University of Hong Kong

# ABSTRACT (DAY 2)

Dr. Tao YANG
City University of Hong Kong

## Chemically complex intermetallic alloys for advanced structural applications

Abstract: Intermetallic materials are bestowed by diverse ordered superlattice structures together with many unusual properties. In particular, the advent of chemically complex intermetallic alloys (CCIMAs) has received considerable attention in recent years and offers a new paradigm to develop novel metallic materials for advanced structural applications. These newly emerged CCIMAs exhibit synergistic modulations of structural and chemical features, such as self-assembled long-range close-packed ordering, complex sublattice occupancy, and interfacial disordered nanoscale layer, potentially allowing for superb physical and mechanical properties that are unmatched in conventional metallic materials. In this talk, we would like to introduce the historical developments and recent advances in ordered intermetallic materials from the simple binary to chemically complex alloy systems. We are focused on the unique multicomponent superlattice microstructures, nanoscale grain-boundary segregation and disordering, as well as the various extraordinary mechanical properties of these newly developed CCIMAs. Finally, perspectives on the future research orientation of this new frontier are presented.

Moderator: Prof. Ji-Jung KAI, City University of Hong Kong

Dr. Zengbao JIAO
The Hong Kong Polytechnic University

## Ultrastrong and ductile high-entropy alloys with coherent nano-lamellar architectures

Abstract: Nano-lamellar materials with ultrahigh strengths and unique physical properties are of technological importance for structural applications. However, these materials generally suffer from low tensile ductility, which severely limits their practical utility. In this talk, we show that markedly enhanced tensile ductility can be achieved in coherent nano-lamellar high-entropy alloys, which exhibit an unprecedented combination of over 2 GPa yield strength and 16% uniform tensile ductility. The ultrahigh strength originates mainly from the lamellar boundary strengthening, whereas the large ductility correlates to a progressive work-hardening mechanism regulated by the unique nano-lamellar architecture. The coherent lamellar boundaries facilitate the dislocation transmission, which eliminates the stress concentrations at the boundaries. Meanwhile, deformation-induced hierarchical stacking-fault networks and associated high-density Lomer-Cottrell locks enhance the work hardening response, leading to unusually large tensile ductilities. The coherent nano-lamellar strategy can potentially be applied to other alloys and open new avenues for designing ultrastrong-yet-ductile materials for technological applications.

Moderator: Prof. Mingxin HUANG, The University of Hong Kong

# ABSTRACT (DAY 2)

Prof. Dierk RAABE
Max Planck Institute for Iron Research

## How to make high strength Aluminium alloys resistant to hydrogen embrittlement

Abstract: High strength aluminium alloys are backbone structural materials for electrical vehicles, planes and spaceships. They must fulfil (at least) the following criteria: high strength, good formability, recyclability and mass producibility, and resistance to corrosion and hydrogen embrittlement [1].

The first two criteria require to design alloys with complex microstructures which introduces multiple local galvanic elements and undesired interfacial decoration phenomena that affect corrosion and hydrogen embrittlement. The sustainability criterion of making such alloys fully recyclable introduces the challenge of compositional variation and the intrusion of undesired tramp elements, both of which also influence the materials' behaviour in real environments [2].

In this presentation we discuss the specific influence of these features on hydrogen embrittlement. For this purpose, we performed atomic-scale investigations of hydrogen trapped in second-phase particles and at grain boundaries in a high-strength 7xxx Al alloy [3,4]. We used these observations to guide atomistic ab initio calculations, which show that the co-segregation of alloying elements and hydrogen favours grain boundary decohesion, and the strong partitioning of hydrogen into the second-phase particles removes solute hydrogen from the matrix, hence preventing hydrogen embrittlement. Our insights advance the mechanistic understanding of hydrogen-assisted embrittlement in Al alloys, emphasizing the role of hydrogen traps in minimizing cracking and guiding future hydrogen-resistant alloy design.

1. D. Raabe et al.: Making Sustainable Aluminum by Recycling Scrap: The Science of “Dirty” Alloys. Prog. Mater. Sci. 2022, 100947
2. D. Raabe, D. et al.: Strategies for Improving the Sustainability of Structural Metals. Nature 2019, 575, pp 64–74.
3. H. Zhao et al.: Hydrogen Trapping and Embrittlement in High-Strength Al-Alloys. Nature 2022, 602, pp 437–441.
4. H. Zhao et al.: Interplay of Chemistry and Faceting at Grain Boundaries in a Model Al Alloy. Phys. Rev. Lett. 2020, 124 (10)

Moderator: Prof. Mingxin HUANG, The University of Hong Kong

# BIOGRAPHY AND PHOTO

## Featured Speaker

### Prof. Ke LU

Professor Ke Lu (B. S. in materials science and engineering, Nanjing University of Science & Technology, 1985; PhD in MSE, Institute of metal Research of CAS, 1990) is a professor and the founding director of Shenyang National Laboratory for Materials Science (SYNL). He was a visiting professor in Max-Planck-Institut für Metallforschung (Stuttgart, Germany) and in University of Wisconsin-Madison (USA).

Professor Lu's icon scientific achievements include two parts:

(1) Discovery of nano-twinned materials and development of the nano-twin strengthening methodology. Traditional strengthening methodologies of materials (such as alloying, strain-hardening, dispersion strengthening, etc.) invariably suffer from an undesirable consequence that strength increases at an expense of ductility and thermal and/or electrical conductivity. Professor Lu and his co-workers discovered that by generating high density of nano-scale twins in grains, pure copper is strengthened by one order of magnitude while keeping its high electrical conductivity and a considerable ductility. They identified that the high density of twin boundaries may effectively block dislocation motions to strengthen materials, and at the same time, twin boundaries may act as dislocation slip planes to accommodate strains. With this discovery, Professor Lu and his collaborators developed a novel strengthening methodology, i.e., nano-twin strengthening, overcoming the conventional property trade-offs.

(2) Development of surface nanocrystallization of metals, from concept and principles to processing technology. Based on plastic deformation induced grain refinement mechanism, Professor Lu and his collaborators invented mechanically-driven surface nanocrystallization processes such as surface mechanical attrition treatment (SMAT) and surface mechanical grinding treatment (SMGT) techniques to transform the coarse-grained structures into gradient nano-grained structures in surface layers on bulk metals. Such an elastic-homogeneous and plastic-heterogeneous gradient architecture provides a unique structure to upgrade the overall properties and performance of the bulk materials, including mechanical properties, surface chemical reactivity, and tribological behaviors of engineering materials. They discovered that with a gradient nano-grained surface layer, strength of a pure Cu bar can be doubled while its tensile ductility remains unchanged. The extraordinary intrinsic plasticity of gradient nano-grained structures offers a great potential for use as advanced coatings of bulk materials. Recently, by means of SMGT processing of nickel Professor Lu discovered ultra-hard and ultra-stable nano-laminated structures with low-angle boundaries, which offers a novel strong-and-stable nanostructure in metals.

He authored and co-authored more than 380 international peer-reviewed journal publications, held 30 patents, and presented over 100 invited lectures at international conferences and symposia. His publications received more than 20000 ISI citations. He is a member of the Chinese Academy of Sciences (2003), a member of German National Academy of Sciences Leopoldina (2005), and a member of TWAS (2004). He is an editor of Progress in Materials Science (Elsevier) and a reviewing editor of Science (AAAS). He received Humboldt Research Award (AvH Foundation, Germany, 2011), THERMEC Distinguished Award (Canada, 2006), TWNSO Award in Technology (TWAS, 2000), Kelly Lecturer (University of Cambridge, UK, 2010). He is a Fellow of the AAAS (USA), MRS (USA), and APAM

# BIOGRAPHY AND PHOTO

## Keynote Speakers

### Prof. Zhaoping LU

Prof. LU is the vice president and professor of University of Science and Technology Beijing. He was awarded the National Science Fund for Distinguished Young Scholars in 2007. He currently serves as the chief editor of international journal of Intermetallics and associate editor of a few other journals. He is also a national council member of Chinese Materials Research Society.

Prof. LU has expertise in the physical metallurgy and mechanical properties of bulk metallic glasses, high-entropy alloys and high-performance steels. His research interests are in the microstructure-property relationships of metallic materials, with special emphasis on strengthening and toughening mechanisms of ultrastrong materials facing extreme service environments. He has granted for more than 60 patents and authored more than 280 publications in peer-reviewed journals including Nature, Science, Nature Materials, etc., which were cited more than 25,000 times. His research work has garnered international recognition and been highlighted many times by Science, Nature, Nature Materials and Materials Today as a new and important development in materials science. One of his research work was selected as “the Top 10 Scientific Achievements of China” in 2017, and he is a winner of First prize in the natural science award of the Ministry of Education in 2017 and Second Prize of National Natural Science Award in 2018, and a co-winner of R&D 100 Award in 2009.

### Prof. Dierk RAABE

Dierk Raabe studied music (conservatorium Wuppertal, Germany), metallurgy and metal physics (RWTH Aachen, Germany). After his doctorate 1992 and habilitation 1997 at RWTH Aachen he received the Heisenberg fellowship award of the German Research Foundation and worked at Carnegie Mellon University (Pittsburgh) and at the National High Magnet Field Lab (Tallahassee). He joined Max Planck Society as a director in 1999. His interests are in computational materials science, phase transformation, alloy design, hydrogen, sustainable metallurgy and atom probe tomography. He received the Leibniz award (highest German Science award), 2 ERC Advanced Grants (highest European research Grant) and the Acta Materialia Gold Medal Award. He is a professor at RWTH Aachen and honorary professor at KU Leuven. He is a member of the National Academy Leopoldina.

# BIOGRAPHY AND PHOTO

## Keynote Speakers

### Dr. Douglas YU

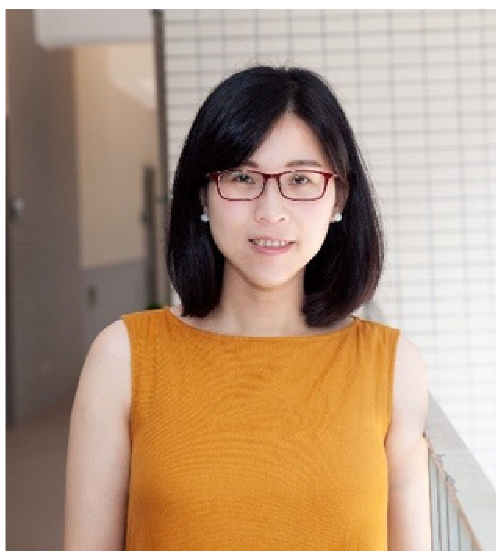
Dr. Douglas Yu is a Distinguished Fellow and Vice President of Pathfinding for System Integration at Taiwan Semiconductor Manufacturing Co. Ltd. (TSMC), responsible for forward looking study on advanced system integration technology.
Dr. Yu joined TSMC in 1994, serving in a variety of roles throughout his career including SoC backend processing technology R&D. In that role, he developed technologies critical to the Company's highly successful transition to copper process at the 0.13 micron generation. Dr. Yu also pioneered TSMC's 3DFabricTM, aka WLSI (wafer-level system integration) technology platform and delivered Chip-on-Wafer-on-Substrate (CoWoS®), Integrated Fan-Out (InFO), and TSMC System-on-Integrated-Chips (SoIC™), as well as their derivatives. Prior to joining TSMC, Dr. Yu was a Member of Technical Staff and Project Leader at AT&T Bell Labs in USA, working on sub-micron process, low power device and integration technologies R&D.
Dr. Yu became an IEEE Fellow in 2013 and received the Presidential Science Prize (highest Taiwan science award 2017), IEEE EPS Outstanding Manufacturing Technology Award (2018), and IEEE Rao Tummala Award (EPS technical field award 2022). He has been granted > 1,400 US patents and published numerous journal and conference papers. He received his B.S. degree in Physics and M.S. degree in Materials Science and Engineering both from National Tsing Hua University, Taiwan and Ph.D. in Materials Engineering from Georgia Institute of Technology, USA.

## Invited Speakers

### Prof. Chih CHEN

Chih Chen received his Ph.D. degrees in Materials Science of University of California at Los Angeles (UCLA) in 1999 in Prof. King-Ning Tu's group. He served as lecturer at UCLA MSE from 1999-2000. He joined National Yang Ming Chiao Tung University (NYCU), Taiwan as an assistant professor in 2000. He is currently the chairman & distinguished professor of Department of Materials Science and Engineering in NYCU, Taiwan.
Professor Chen discovered electrodeposition of (111)-oriented nanotwinned Cu, and reported it in Science 336, 1007-1010 (2012), and transferred the fabrication technology to Chemleaders, Inc, Taiwan for mass production in 2016. Therefore, he received the 2016 National Innovation Award, 2016 Materials Innovation Award, Materials Research Society, Taiwan, 2017 Outstanding Technology Transfer Award on Electroplating and Application of High (111)-oriented Nanotwinned Cu, 2018 Outstanding Researcher Award, Ministry of Science & Technology, Taiwan. TMS 2018 Research to Practice Award, The Minerals, Metals & Materials Society (TMS), USA. It is noteworthy to mention that TMS is the second largest materials society in the world and there are over 4000 members in TMS. There is only one recipient each year for the Research to Practice Award. He was recognized as fellow of International Association of Advanced Materials (IAAM) in 2020 and Fellow of The Materials Research Society-Taiwan (MRS-T) in 2022.
His current research interests are low-temperature Cu-to-Cu direct bonding, high strength nanotwinned Cu lines and films for 3D IC integration, reliabilities of flip-chip solder joints and microbumps for microelectronics packaging, including electromigration, thermomigration, and metallurgical reactions. He published 190+ journal papers and he holds 30+ Taiwan and US patents. He wrote a book with Prof. King-Ning Tu and Prof. H.M. Chen on Electronic Packaging Science and Technology, which has been published by Wiley in 2021.

# BIOGRAPHY AND PHOTO



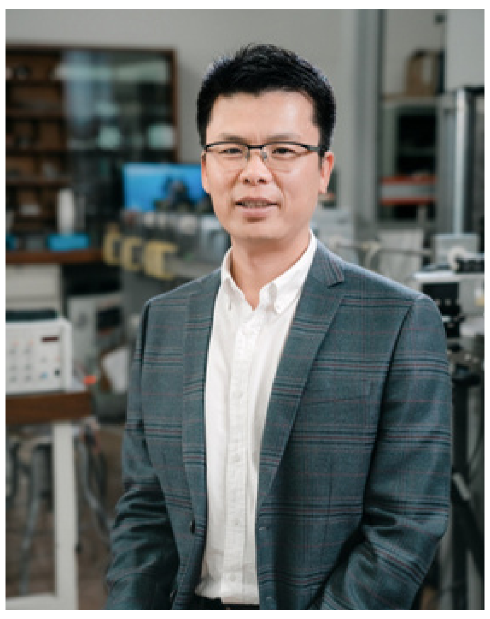
## Prof. Yi-Chia CHOU

Dr. Yi-Chia Chou (周苡嘉) is a Professor in the Department of Materials Science and Engineering at National Taiwan University. She received her B.Sc. degree in Materials Science and Engineering from National Tsing Hua University at Hsinchu, Taiwan and Ph.D. degree from University of California Los Angeles in CA, USA. She was a visiting student at Lawrence Berkeley Laboratory with support of a fellowship. Her postdoc research was at IBM Thomas J. Watson Research Center and was appointed as a guest scientist at Brookhaven National Laboratory. Before joining NTU, she was a professor in the Department of Electrophysics at National Yang Ming Chiao Tung University.
Her research interests focus on fundamental understanding of materials science including the reactions in semiconductors, the growth of semiconductor nanostructures, and the microstructure and defect in high entropy alloys analyzed using high performance transmission electron microscopy.
She was a recipient of UCLA Graduate Fellowship in 2006, a recipient of Dissertation Fellowship Award in 2010, and a recipient of TSMC Outstanding Graduate Student Award in 2010. For her achievement at postdoc research on investigation of the growth of Si/Ge heterojunction nanowires with alloy catalysts using in situ UHV-TEM and Cs-corrected ETEM, she was awarded Presidential Postdoctoral Award from Microscopy Society of America in 2012. She was awarded as Taiwan Promising Women in Science in 2019, IBM Faculty Award in 2017, and Ministry of Science and Technology (MOST) Young Scholar Fellowship-Columbus Project (2018-2023), for her career in Taiwan.

## Prof. Andriy M. GUSAK

Prof. Andriy M. Gusak graduated from the Moscow State University with honours, specializing in theoretical physics. Then he received the PhD degree at the Institute of Metallurgy, Academy of Sciences of USSR (Moscow). Currently, Prof. Gusak serves in the Department of Physics at Cherkasy National University, Ukraine.
His research works focus on the kinetics of solid-state reactions in particular soldering and SHS kinetics. He is also interested in theories and models of interdiffusion and reactive diffusion in binary and multicomponent multiphase alloys. Prof. Gusak received research grants from the Ministry of Education and Science of Ukraine for seven times, and was granted for State Fund of Fundamental Research of Ukraine for four times.
Prof. Gusak is a regular member of the advisory board of International Conference on Diffusion in Materials (DIMAT). Besides, he organized five international conferences on diffusion and phase transformation (DIFTRANS, DSSR) in1998, 2001, 2004, 2007, and 2012 in Cherkasy region.

# BIOGRAPHY AND PHOTO



## Prof. Mingxin HUANG

Prof. Huang received his BEng and MSc from Shanghai Jiao Tong University (SJTU) in 2002 and 2004, respectively, and his PhD in Materials Science in 2008 from Delft University of Technology (TU Delft), The Netherlands. Prof. Huang's research interests focus on two areas: (1) fundamentals of microstructure-property relationship and phase transformation of advanced steels and alloys, and (2) development of lightweight materials for automotive applications.

Prof. Huang has published 130+ SCI journal papers on top international journals in the field such as Science, Science Advances, Acta Materialia etc. Huang is the Editor, Associated Editor, Editorial Board Member of several international journals. Prof. Huang is a Fellow of IMMM and Member of Hong Kong Young Academy of Sciences. Prof. Huang received the prestigious Xplorer Prize 2021, and is named the Top 1% Most Cited Researcher by Clarivate Analytics.

## Dr. Zengbao JIAO

Dr. Jiao is an Associate Professor at the Department of Mechanical Engineering, The Hong Kong Polytechnic University (PolyU). He received his PhD from City University of Hong Kong in 2014 and worked as a postdoc at CityU in 2015 and at MIT in 2016. He joined PolyU as an Assistant Professor in 2017 and was promoted to Associate Professor with tenure in 2022.

Dr. Jiao's research interests focus on the development of advanced structural materials, including ultra-high strength steels, high-entropy alloys, high-temperature superalloys, intermetallics, and nanostructured alloys. His work was published in high-profile journals such as Science, Nature Communications, Materials Today, and Acta Materialia. He serves as an associate editorial board member of Materials Research Letters and received twice the Acta Materialia & Scripta Materialia Outstanding Reviewer Award.

## Prof. Peter K. LIAW

Peter K. Liaw obtained his B.S. in Physics from the National Tsing Hua University, Taiwan, and his Ph.D. in Materials Science and Engineering from Northwestern University, US, in 1980. After working at the Westinghouse Research and Development (R&D) Center for thirteen years, he joined the faculty and became an Endowed Ivan Racheff Chair of Excellence in the Department of Materials Science and Engineering at The University of Tennessee (UT), Knoxville in March 1993. He has worked in the areas of fatigue, fracture, nondestructive evaluation, and life-prediction methodologies of structural alloys and composites. Since joining UT, his research interests include mechanical behavior, neutron and synchrotron diffraction, bulk-metallic glasses, high-entropy alloys, and processing of high-temperature alloys and ceramic-matrix composites and coatings, with the kind help of his team members and colleagues at UT and Oak Ridge National Laboratory, and throughout the world. He has published one thousand, one hundred, and six journal papers, edited and written sixty-two books and book chapters, and presented numerous plenary, keynote, and invited talks at various national and international conferences.

## BIOGRAPHY AND PHOTO

He was awarded the Royal E. Cabell Fellowship at Northwestern University. He is the recipient of numerous "Outstanding Performance" awards from the Westinghouse R&D Center. He was the Chairman of The Minerals, Metals and Materials Society (TMS) "Mechanical Metallurgy" Committee, and Chairman of the American Society for Metals (ASM) "Flow and Fracture" Committee. He has been the Chairman and Member of the TMS Award Committee on "Application to Practice, Educator, and Leadership Awards." He is a Fellow of ASM, MRS, and TMS. He has been given the Outstanding Teacher Award, the Moses E. and Mayme Brooks Distinguished Professor Award, the Engineering Research Fellow Awards, the National Alumni Association Distinguished Service Professor Award, the L. R. Hesler Award, and the John Fisher Professorship at UT, the TMS Distinguished Service Award, and a 2020 TMS Symposium dedicated to him. He has been the Director of the National Science Foundation (NSF) Integrative Graduate Education and Research Training (IGERT) Program, the Director of the NSF International Materials Institutes (IMI) Program, and the Director of the NSF Major Research Instrumentation (MRI) Program at UT. Several of his graduate students have been given awards for their research, papers, and presentations at various professional societies and conferences. Moreover, his students teach and conduct research at universities, industries, and government laboratories.

### Dr. Yingxia LIU

Dr. Yingxia Liu is currently a tenure-track assistant professor at the City University of Hong Kong, working on reliability issues in advanced electronic packaging. Before joining CityU in 2021, Dr. Liu worked at Intel as a Quality and Reliability R&D Engineer, in charge of solving the issues related to Intel's embedded multi-die interconnect bridge (EMIB) technology. Dr. Liu received her Ph.D. from the Department of Materials Science and Engineering, University of California, Los Angeles in 2016 and a bachelor's degree from the College of Chemistry and Molecular Engineering, Peking University in 2012. The research interest of Dr. Liu includes systematic reliability tests to predict lifetime and fundamental studies on the next generation materials in advanced electronic packaging structures. Her current research also focuses on the anti-pathogen effect of metal materials. Her work was published in Acta Materialia, Scripta Materialia, Applied Physics Review, etc.

### Prof. Yong LIU

Prof. Yong Liu, is the Director of Powder Metallurgy Research Institute of Central South University. He got his Ph.D. degree of Materials Science in the same institute in 1999, and then, has been working there for more than 20 years. He also was a visiting scientist in Oak Ridge National Laboratory during 2005-2006, and in RWTH Aachen University during 2009-2011. His research field covers high temperature structural materials, titanium alloys and hard materials, usually through the technique route of powder metallurgy. He has won many academic honors, including Alexander von Humboldt Fellowship, and National S&T Award of China, published more than 100 peer-reviewed papers in various journals, and also more than 50 patents. He is now serving as editors for such journals as Intermetallics and Materials Characterization.

# BIOGRAPHY AND PHOTO

## Prof. Nikolaus OSTERRIEDER

Klaus is currently Dean of the Jockey Club College of Veterinary Medicine and Life Sciences at City University. He previously served as Professor of Virology and Chair at Freie Universität Berlin, Germany (2007 – 2020), and Adjunct Professor of Virology at Cornell University (2007 – present). After finishing his veterinary degree in 1990, Klaus entered the field of virology, initially working with poxviruses. After his dissertation in 1993, his scientific focus switched to herpesviruses, specifically to work with equine herpesvirus type 1 (EHV-1). He completed his "Habilitation" in 1997. In the same year, Klaus started to work as a group leader at the Friedrich-Loeffler-Institute in Insel Riems, and began his investigations of an oncogenic herpesvirus, Marek's disease virus (MDV) of chickens. He has continued to work on these two herpesviruses during his time on the faculty at Cornell and in Berlin. More recently his research extended into influenza and coronaviruses (SARS- and MERS-CoV, infectious bronchitis virus of chickens, and canine coronaviruses).

Klaus is an avid advocate of using natural virus-host systems, because of their unique model character and because they allow harnessing the strength of collaboration with clinicians and researchers from other disciplines. Using infectious clones and reverse genetics, his laboratory mechanistically studies viral pathogenesis and utilizes this knowledge for engineering of modified live virus vaccines. His research has been funded continuously since 1994 by public funding agencies including the European Union, the NIH, the USDA, the DFG and other public sources. He has also secured support for his work from pharmaceutical companies and philanthropists. Klaus has more than 230 scientific publications and his h-index currently stands at 51. He is editor and member of the editorial board of a number of journals, and his honors include membership in the Academy of Sciences of Thuringia since 2014, the Young Investigator Award of the Academy for Animal Health (2002) and the WVPA-Boehringer Ingelheim Vaccine Innovation Award (2017).

## Prof. Lit Man Leo POON

Professor Leo Poon graduated from HKBU in 1994. He received his doctoral training in Sir William Dunn School of Pathology in University of Oxford (1996-1999). He joined the University of Hong Kong as a Research Assistant Professor in 2001. He currently serves as a Professor in the School of Public Health, HKU.

Professor Poon has strong interests on emerging viruses. He published over 260 peer-reviewed articles. He is a founding member of the Hong Kong Young Academy of Sciences. He was awarded a Senior Research Fellowship by the Croucher Foundation in 2017. He has been named as a top 1% most-cited scientist since 2005 and, an even more prestigious honour, as a Highly Cited Researcher since 2015.

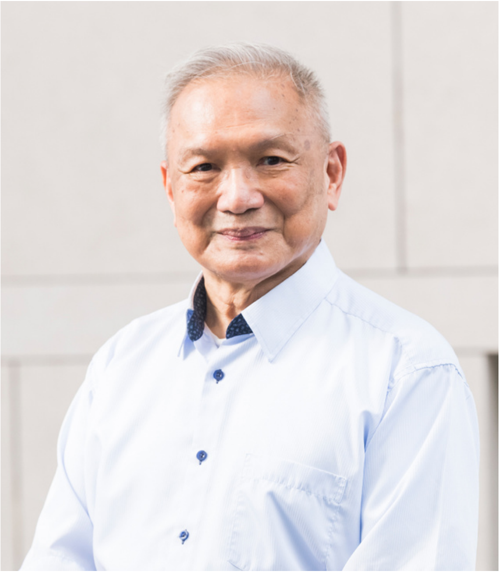
His work primarily focuses on influenza virus and coronavirus. In 2003, Professor Poon involved in the discovery of a novel coronavirus as the aetiological cause of SARS. He is the first who decoded the first SARS coronavirus sequence. In the current COVID-19 pandemic, his work led to several key discoveries about SARS-CoV-2. His findings helped to develop evidence-based control measures to control COVID-19. He and his team currently still actively research on SARS-CoV-2, such as the molecular epidemiology of SARS-CoV-2 in Hong Kong.

Professor Poon serves as an expert for several international organisations. He is a committee member in the Coronavirus Study Group under the International Committee on Taxonomy of Viruses and he is also an expert in different WHO Working Groups for SARS-CoV-2 and influenza virus. He is also an ad hoc consultant for the Food and Agriculture Organization of the United Nations and for the World Organization for Animal Health.

# BIOGRAPHY AND PHOTO

## Prof. Xinping QU

Xin Ping Qu received the B.S. degree in solid state electronics from Huazhong University of Science and technology in 1993, the M.S. degree from Shanghai institute of Ceramics, Chinese academy of Science in 1996, and the Ph.D. degree in solid state electronics and microelectronics from Fudan university, Shanghai in 1999. Since 2006, she becomes a professor in the same department. She is currently with the School of microelectronics, Fudan University, Shanghai. Her research interest includes novel interconnect technology, such as non-copper conductor, 3D interconnect technology, CMP and post-CMP cleaning, electroplating, high aspect ratio metal filling, etc. She has published more than 150 papers in the refereed journals and international conferences. She severed as program Co- chair or organization Co-chair for many international conferences. She is currently vice director of Chinese CMP user group. She is now IEEE senior member.



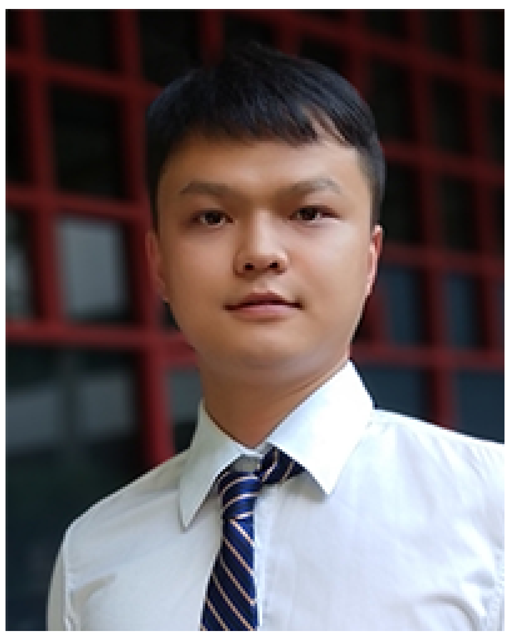
## Prof. King-Ning TU

Professor TU King-Ning is the Chair Professor of Materials and Electrical Engineering of the City University of Hong Kong. Professor Tu received his BSc degree from National Taiwan University, MSc degree from Brown University, and PhD degree on applied physics from Harvard University in 1968. Professor Tu has been the TSMC Chair Professor and E. Sun Scholar of National Chiao Tung University, Taiwan. Professor Tu is a world leader in the science of thin films, especially in its applications in microelectronic devices, packaging and reliability. His recent work is on predicting failure in modern microelectronics based on entropy production.

## Prof. Yong YANG

Professor Yang obtained his bachelor’s degree from Peking University in 2001, master’s degree from Hong Kong University of Science and Technology in 2003, and PhD degree from Princeton University in 2007. He is now affiliated with several departments in College of Engineering at City University of Hong Kong, and his current research interest includes nanomechanics, design of advanced bulk alloys (e.g., bulk metallic glasses, high entropy alloys) and low dimensional alloys/ceramics (e.g., nanosheets, nanowires, nanoparticles), materials informatics, nano-manufacturing and additive manufacturing (e.g., binder jet 3D printing). His work has been published in multi-disciplinary journals and leading journals in materials, such as Nature, Nature Materials, Nature Communications, Science Advances, PNAS, Advanced Materials, Materials Today, Nano Letters and etc.

# BIOGRAPHY AND PHOTO



## Dr. Tao YANG

Dr. Yang is currently an Assistant Professor at the Department of Materials Science and Engineering in City University of Hong Kong. His research focuses on the innovative design and fabrication of advanced metallic materials for structural and functional applications, including the high-entropy alloys, intermetallic materials, high-temperature superalloys, deep cryogenic alloys and electrocatalysis materials. His current work is primarily focused on the control of nanoprecipitation, grain-boundary characters, and atomic structures by using multiple state-of-the-art techniques, such as the 3D atom probe tomography (3D-APT), high-resolution transmission electron microscope (HETEM), and 3D printing.

## Dr. Ruquan YE

Ruquan Ye is an assistant professor in Chemistry, City University of Hong Kong. He received his B.S. (Chemistry) in 2012 from Hong Kong University of Science and Technology under Prof. Ben Zhong Tang's supervision, and his Ph.D. (chemistry) in 2017 from Rice University mentored by Prof. James M. Tour. He worked with Prof. Karthish Manthiram as a postdoctoral associate in Chemical Engineering at the Massachusetts Institute of Technology (2017–2018). He was named World's Top 2% scientists by Standford University in 2020 and 2021. He was awarded Rising Stars by Small, Wiley in 2021, and Emerging Investigators by Journal of Materials Chemistry A, Royal Society of Chemistry in 2022.

Dr. Ye's current research interests include developing cost-effect methods for materials manufacturing and investigating their applications in energy and environmental science. He is one of the pioneers in developing the laser-induced graphene technique, which uses a readily available CO2 laser to synthesize porous graphene. The laser-induced graphene method has been widely adopted across the globe to fabricate graphene-based films and devices. He also investigated the electrochemical CO2 reduction reactions, aiming to mitigate the carbon emissions while providing valuable chemicals. His research focuses on catalyst synthesis and interface design.

## Prof. Jien-Wei YEH

Professor Jien-Wei Yeh explored and researched high-entropy alloys and related materials since 1995. He believes that there is a high entropy effect ignored before, which can inhibit stoichiometric intermetallic compounds and enhances the formation of solid solution phases. He published more than 240 SCI papers including at least 180 papers on high-entropy materials from 2004 to now. He has named and defined the new alloys; proposed four core effects and established fundamental principles; extended the concept to ceramics and polymers; and paved different ways via casting, wrought, powder metallurgy and coating routes to show the feasibility, phenomena, and potential of high-entropy materials for new comers. In ICHEM-2018, steering committee of the conference elected him as the Chair of International High Entropy Materials Consortium. Moreover, he has more than 33,152 citations, and an H-index of 79 (Scopus, on June 14). He also has at least 40 patents

# BIOGRAPHY AND PHOTO

## Short Talk Speakers

### Dr. Muhammad NAEEM

Dr. Naeem is working as a Postdoc fellow at the Department of Physics, City University of Hong Kong. The focus of his research is on the deformation behavior of multicomponent alloys under extreme thermal conditions. He employs neutron scattering for the in situ structural characterization.
Dr. Naeem has been awarded the AONSA Young Research Fellowship by the Asia-Oceania Neutron Scattering Association. He also received the award of Best Paper on Materials from the Hong Kong Institution of Engineers in 2020. His work has been published in Science Advances, Acta Materialia, Scripta Materialia, Applied Physics Letters, etc.

### Dr. Zhaoxuan WU

Zhaoxuan Wu is Assistant Professor in the Department of Materials Science and Engineering, City University of Hong Kong. He received his PhD in integrative science and engineering from National University of Singapore in 2011 and worked as a Scientist in the Institute of High Performance Computing, Singapore. Between 2014 and 2016, he did his Postdoc and worked as Scientist in the Institute of Mechanical Engineering at EPFL, Switzerland. He works on problems in solid mechanics and materials from atomistic to continuum scales, focusing on dislocation, plasticity and fracture in engineering metals and alloys. He is currently studying plasticity, fracture behaviours and alloying effects in hcp metals and Al alloys. He has published papers in various scientific journals such as Science, Nature and PNAS. He received the Outstanding Reviewer Award 2016 for Acta Materialia from Elsevier.

### Dr. Shijun ZHAO

Dr. Shijun Zhao is an Assistant Professor at the City University of Hong Kong. Dr. Zhao received his bachelor’s degree in Physics and Ph.D. degree in Nuclear Engineering, both from Peking University. After postdoctoral research at Peking University and Oak Ridge National Laboratory, Dr. Zhao joined the Department of Mechanical Engineering at the City University of Hong Kong.

Dr. Zhao’s current research group focuses on computational materials science, especially high entropy materials, including alloys and ceramics. His group aims to understand defect thermodynamics and kinetics under deformation or irradiation conditions. For this purpose, different simulation techniques at different scales are concurrently or sequentially employed.

# BIOGRAPHY AND PHOTO

## Organizing Committee Members

### Dr. Yingxia LIU

Please refer to p. 20 for biography and photo

### Dr. Zhaoxuan WU

Please refer to p. 24 for biography and photo

### Dr. Tao YANG

Please refer to p. 23 for biography and photo

# BIOGRAPHY AND PHOTO

## Co-Chairs

### Prof. Chain-Tsuan LIU

Professor C.T. Liu is a member of National Academy of Engineering (NAE), USA, a foreign member of Chinese Academy of Engineering, and an academician of Academia Sinica, Taiwan. He is currently the University Distinguished Professor at City University of Hong Kong. He is a world leader in the field of intermetallic and metallic materials. His innovative research has led to the design of new structural materials with superior mechanical properties for engineering applications. He has published more than 600 journal papers and been granted 30 US patents. Professor Liu has received numerous honours and awards, including Acta Metallurgica Gold Medal Award, the E.O. Lawrence Award (a US President award) from USDOE, Brown Engineering Alumni Award from Brown University, the first Henry J. Albert Award from IPMI, Fellow Awards from five professional societies – Japan Institute of Metals, the World Technology Network, TMS, ASM, and IPMI.

### Prof. King-Ning TU

Please refer to p. 22 for biography and photo