Haonan Yang
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Education:

Ph.D. Electrical Engineering
The University of Manchester, UK | 2021-2025
PhD Thesis: Molecular Dynamics Simulation of the Cathode Spot Mechanism and the Effect of Material Modification on Reducing Contact Erosion.

M.S. Electrical Engineering
Tsinghua University, China | 2019-2021
MSc Dissertation: Research on the Driving and Holding Technology of Direct Current 110kV Ultra-Fast Mechanical Disconnector

B.S. Electrical Engineering
Tsinghua University, China | 2015-2019
UG Final-year Project: Research on the Motor Drive Technology of 145kV Vacuum Circuit Breakers

Research Experience:

Circuit Breaker Research:

- PhD project: Development of Erosion-Resistant Vacuum Interrupter as SF6 Alternative.
  - Conducted multi-physics simulations to characterize cathode and anode behaviour under vacuum arcing.
  - Established a mathematical model of cathode spot dynamics to elucidate erosion mechanisms and guide material selection.
- MSc Project: Prototype Development and Simulation of a Vacuum Circuit Breaker.
  - Designed and constructed a VCB prototype integrating an electromagnetic drive/buffering mechanism and permanent magnetic holding system.
  - Developed custom simulation tools to optimize the electromagnetic drive and buffering performance, enhancing overall VCB reliability and operational efficiency.
- MSc supervision: Analysis of Post-Arc Dielectric Recovery in Vacuum Circuit Breakers.
  - Developed a Molecular Dynamics model to simulate anode surface evolution and plasma decay during post-arc.
  - Revealed the coupled effects of surface evaporation, plasma generation, and expansion on dielectric recovery strength.

Transformer Research:

- PhD secondment: Molecular Dynamics Study of Bubble Formation in Oil-Paper Insulation.
  - Built and simulated a composite oil-cellulose interface model to track water molecule diffusion and aggregation.
  - Identified the nucleation conditions for bubble formation under thermal stress, providing insights for insulation failure prevention.
- MSc supervision: Digital Twin Framework for Transformer Health Index Prediction.
  - Developed a digital twin prototype integrating sensor data and aging models to estimate

transformer condition.
  - Enabled predictive maintenance scheduling by linking health index trends to asset management decisions.

CB-Transformer-System Interaction Studies:

- PhD project: Capacitive Current Switching Performance in Vacuum Circuit Breakers.
  - Simulated contact behaviour and post-arc dielectric recovery under high-frequency capacitive load conditions.
  - Assessed the risk of dielectric failure and restrike when switching transformer magnetizing or cable charging currents.
- MSc supervision: Power System Impact of VCB Restrike after Current Interruption.
  - Modelled Transient Recovery Voltage (TRV) evolution after interruption using PSCAD/EMTDC.
  - Evaluated the impact of system parameters on TRV shape and the consequences of restrike on system overvoltage.

Honors & Activities:

- CIGRE UK Manchester Hub – Vice Chair
- CIGRE WG A2.76 – Member
- CIGRE Paris Session 2024 – Honourable Mentions in NGN competition
- Postgraduate student of the year 2025 in UoM – EEE representative
- UHVnet 2022 – Best Presentation Award
- Tsinghua University 2018 – Comprehensive Academic Scholarship

Publications:

[1]. **Yang H**, Shen S, Xu R, Zhou M, Yan J, and Wang Z D. Molecular dynamics simulation of cathode crater formation in the cathode spot of vacuum arcs. Journal of Physics D: Applied Physics, 2023, 56(37): 375203.

[2]. **Yang H**, Shen S, Xu R, Zhou M, and Wang Z D. Investigation into the mechanism of surface atom emission from an individual cathode spot using molecular dynamics simulation. Journal of Physics D: Applied Physics, 2024, 57(13): 135203.

[3]. **Yang H** and Wang Z D. Molecular Dynamics Simulation Study of Mechanisms of Cathode Spot Evolution: Three-stage Pattern, Mathematical Model Derivation, and Discussions. Plasma Sources Science and Technology, 2025, to be publish.

[4]. **Yang H** and Wang Z D. Investigation into material effect on cathode spot evolution based on Molecular Dynamics Simulation. Journal of Physics D: Applied Physics, 2025, to be publish.

[5]. Zhou M, Xu R, Ding Y, **Yang H**, Shanika M, and Wang Z D. Molecular Dynamics Simulation of Behaviours of W/Graphene Enhanced Cu-Cr Anode in Vacuum Arc. Plasma Science Technology. 2025, to be publish.

[6]. **Yang H**, Shen S, Wang Z D, Xu R, and Zhou M. Simulation of ion bombardment of dense plasma on cold cathode by Molecular Dynamics //2023 30th International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV). IEEE, 2023: 294-297.

[7]. **Yang H**, Shen S, and Wang Z D. Simulation into influence of contact materials on cathode spot formation in vacuum circuit breaker //2023 23rd International Symposium on High Voltage Engineering (ISH).

[8]. **Yang H**. Molecular Dynamics Simulation of Cathode Spots Formation and Contact Erosion in Vacuum Circuit Breakers //2024 CIGRE Paris Session 2024.

[9]. **Yang H**, Shen S, Shanika M and Wang Z D. Molecular dynamics simulation into the ion effects on the self-sustainment of cathode spots //ICEPE-ST 2024.