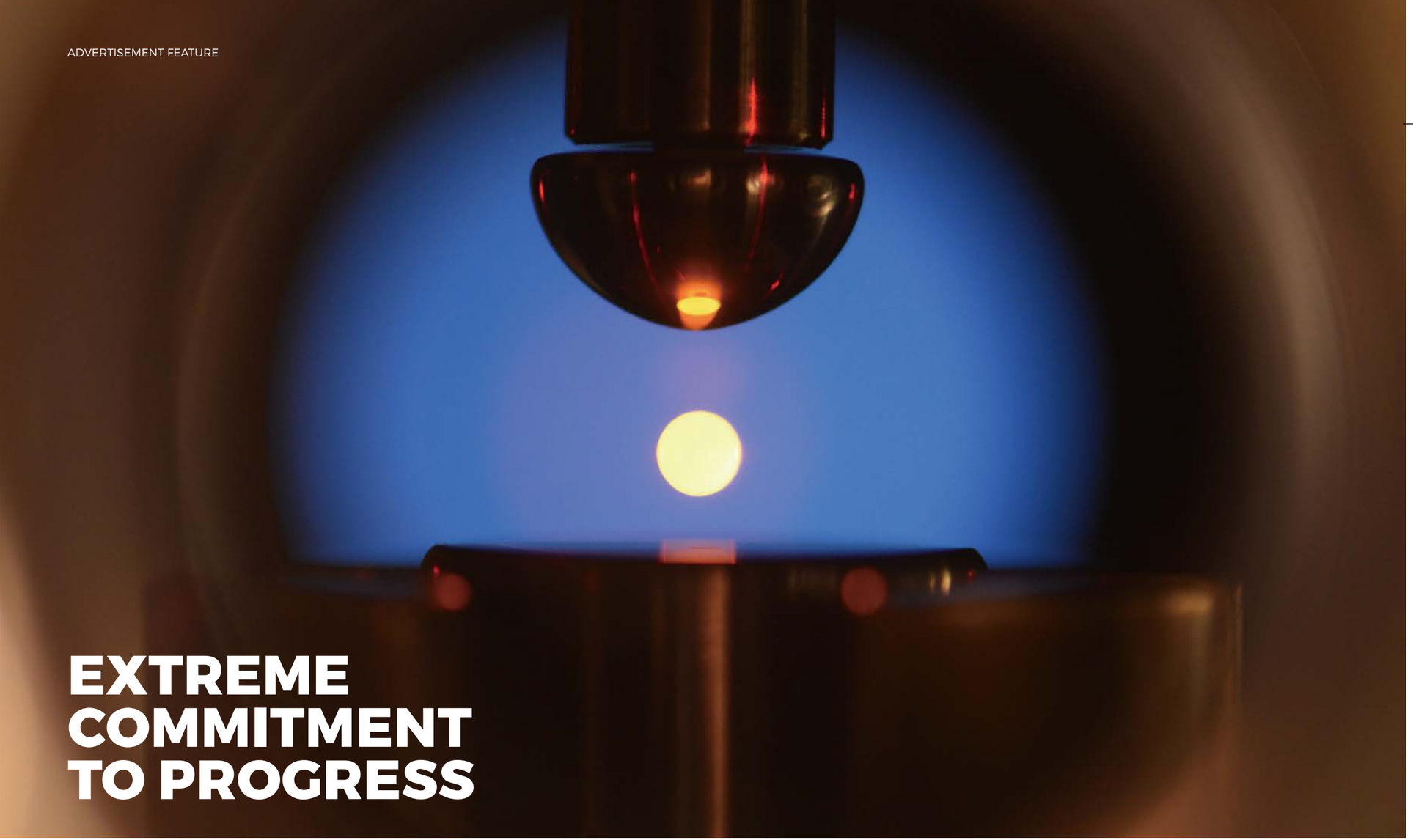

EXTREME COMMITMENT TO PROGRESS

Contributing to China's strategic needs through cutting-edge research, the materials science and engineering programme at Northwestern Polytechnical University (NPU) has developed significant strengths in ultra-high temperature composites, metal additive manufacturing, precision plastic forming, and space materials science.

With a focus on disciplines working together, it integrates materials research with emerging fields to develop nano energy materials, left-handed materials well-known for their unusual optical properties, advanced lubricating or sealing materials, and materials genome engineering.

Materials in extreme environment

Ultra-high temperature structural composites, able to withstand temperatures up to 3000°C, have applications in space vehicles which operate in extreme environments. Researchers have traditionally focussed on enhancing fibre properties and material density to improve the performance. NPU materials scientists proposed a novel theory for strengthening and toughening ceramics, and developed world-leading anti-oxidation ceramic matrix composites that can endure high temperature, and have a long service life. This novel thermal structure material is important for boosting China's manufacturing capacity for advanced aerospace vehicles. The achievement won them the first prize of the National Technology Invention Award in 2004, an honour which had not been bestowed for six years, and was widely recognized at home and abroad.

NPU researchers also made breakthroughs in controllable preparation and lab simulation of large-scale complex components. They established innovative theoretical frameworks for modulating material micro-structures, improving anti-oxidation and anti-ablation properties, and for evaluating material performance in extreme environment.

Tackling the fundamental questions of liquid metals and their phase transition in outer space environments, NPU scientists have developed containerless processing techniques , which simulate outer-space environments and help eliminate contamination in materials preparation. Their electrostatic, electromagnetic and acoustic levitation techniques offer new approaches for materials preparation and property measurement. They have explored containerless preparation of high-temperature refractory alloys, high-entropy alloys and advanced energy storage materials, and investigated their properties, such as surface tension, density, specific heat and viscosity. These have revealed the mechanisms underlying the rapid solidification and thermophysical properties of deeply undercooled multicomponent alloys. Their work has provided theoretical and technological support to China's space station plan, boosting space materials science and technologies.

Materials preparation and manufacturing

NPU researchers also focus on the technical challenges in metal additive manufacturing, such as avoiding distortion and improving mechanical properties when manufacturing high-performance, complex parts. They have created a systematic R&D framework for laser additive manufacturing. Having overcomed the challenge of precise and integrated control of shape and metallurgical quality of parts, they realised high-quality manufacturing of multi-function, strong, lightweight metal and graded materials components. Their equipment is capable of patternless, rapid and near-net forming, as well as repair and re-manufacturing of complex components made of highly active titanium, zirconium or aluminium alloy. They have also established online quality control and evaluation systems for laser additive manufacturing, serving more than 100 companies, universities and research institutes in aerospace and energy fields across the world.

NPU's integrated processing and preparation technological systems to precisely form high-performance lightweight components shed light on addressing issues in high-end equipment manufacturing. The key to their technology is to harness a material's uneven deformation.

NPU materials scientists have a long list of achievements, including: inventing new technology for low-cost preparation of high-performance carbon-carbon composites; revealing the anti-oxidation mechanism and failure mechanism of coatings under high-temperature gas washout; and developing five long-life coating systems for high-temperature protection.

NPU scientists have developed electrostatic, electromagnetic, and acoustic levitation techniques to improve preparation of materials.

Photoelectric materials and devices and beyond

NPU researchers address the needs for next-generation photoelectric materials and devices. They have discovered the mechanism for controlling micro/nano defects and photoelectric properties of II-VI compound semiconductor crystals, typically good candidates for optoelectronics, especially light-emitting devices and radiation detectors. With a well-established system for designing, synthesizing and growing radiation detection materials, such as cadmium zinc telluride (CdZnTe), they have founded China's only enterprise that manufactures third-generation radiation detection materials, core devices and components. Their technologies are applied in more than 40 research or commercial institutions in China and abroad.

In the design of new materials, NPU researchers have developed materials genome technologies, including high-throughput computing, machine learning and high-throughput evolutionary architecture search, which have led to the design of electrides, borophene and high-pressure materials. The atom-thick borophene, with its high conductivity and attractive mechanical and electronic properties, is hailed as a new promising two-dimensional (2D) material as an alternative to graphene.

NPU material scientists have also validated the existence of special structures of the Na-Cl system and helide under high pressure. Results are published in leading journals including *Science*, and *Nature Chemistry*.

Breakthroughs are also seen in studies of lithium batteries, supercapacitors, perovskite solar cells and related devices. Technologies developed at NPU include: low-cost, controllable and large-scale preparation of graphene and other 2D materials; real-time characterization of electrode materials in electrochemical processes; in-situ characterization of nanobio interfaces; and preparation and in-situ characterization of nano materials. ■

Work at NPU has enabled high-quality manufacturing of complex parts.

Advertiser retains sole responsibility for content