High-performance and ultra-precision micro/nano molds electroforming with atomic precision

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As a superb non-conventional electrochemical additive manufacturing technology, ultra-precision electroforming has important application prospects in aerospace core components, weapons, precision molds, optical devices, etc. due to its outstanding advantages such as micro-nano-atomic controllable replication accuracy, optical surface creation, non workpiece size and shape restrictions, and a wide range of material properties control. This report is based on our basic research and application development in the field of ultra-precision electroforming technology. First, it introduces the construction of the LIGA manufacturing platform, and then introduces electroforming as the core enabling technology of LIGA manufacturing, discusses its basic manufacturing theory and key scientific and technological issues, and then takes the application of precision electroforming in the field of micro/nano mold manufacturing as a typical demonstration to launch our achievements in the development of wafer-level electroforming machine tools, the problem of precision error transmission in the LIGA manufacturing process, the problem of thickness uniformity and flatness control of large-area molds, the precision study of variable aspect ratio microstructure molds, and the study on permanent self-lubricating nickel-based micro/nano mold electroforming technology enhanced by two-dimensional materials. Finally, combined with the development of manufacturing frontiers and my own thinking, some suggestions are given on the future development direction of digital twin electroforming technology and atomic-scale/precision electroforming technology.