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Rotation-driven multistable material system with reprogrammable logic for sequential-parallel computing

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ABSTRACT

Recent advances in mechanical information processing are transforming physically embodied intelligence. However, a key challenge remains: achieving high-efficiency sequential information processing. In this work, we present a rotation-driven multistable material system in which mechanical-electrical state transitions are governed by a reprogrammable finite state machine (FSM) that seamlessly integrates elastic mechanical assemblies with non-volatile memory in a reconfigurable electrical network. The built-in combinational logic of the FSM dictates the system's state transitions based on a prescribed sequence of rotational bistabilities and the in-situ switchable assembly of hierarchically coupled mechanical constituents. Elementary logic operations are demonstrated in a single-layer material system, represented by a single-bit FSM, while more complex computing, featuring parallel combinational logic, is achieved in a multi-layer material system. The resulting four-bit material system enables scalable and reprogrammable sequential-parallel digital logic computing. This material framework holds promise for applications in multi-task real-time control and dual-physical encryption, enabling sequential mechanical information sensing, non-volatile storage, and parallel electrical information processing