Multi-State Memory and Multi-Functional Devices Comprising Magnetoplastic or Magnetoelastic Materials – U.S. Patent Issued

Invention
Very small Ni-Mn-Ga crystals have been characterized and responses induced by mechanical, magnetic or temperature changes were identified. The crystals have 6 different states. These states can be identified by measuring the magnetic field or with different types of microscopes and diffraction techniques. The crystals can effectively act as a logic or memory element with 6 states which could provide advantages over the current binary (2-state) logic and memory devices used.

Boise State University has invented a device with simultaneous read&write, sense&indicate, and sense&control capabilities using unique magnetoplastic or magnetoelastic materials.

Application
This system can be used for many applications including device, sensor, actuator, logic and memory.

- Parties of interest: Companies may include; Micron Technology, Hewlett Packard, IBM, Freescale (Motorola) and Intel.

Advantages
- The crystals have 6 different identifiable states so can effectively act as a logic or memory element with 6 states which could provide advantages over the current binary (2-state) logic and memory devices used.
- Ni-Mn-Ga crystals have 6 identifiable states based on mechanical, temperature, or magnetic changes resulting in more powerful logic/memory devices.
- The memory devices created with this shape memory material is non-volatile, meaning it will not lose its state when the electrical signal is lost, resulting in faster loading and shutdown times with computers among other things.
Multi-State Memory and Multi-Functional Devices Comprising Magnetoplastic or Magnetoelastic Materials – U.S. Patent Issued

Patent Abstract
Apparatus and methods are disclosed that enable writing data on, and reading data of, multi-state elements having greater than two states. The multifunctionality of the multi-state elements allows for simultaneous operations including read&write, sense&indicate, and sense&control. Embodiments of the invention may be used, for example, for storing, modifying, and accessing data for device, sensor, actuator, logic and memory applications. Embodiments may be particularly effective for non-volatile memory or other read&write, sense&indicate, and/or sense&control functions in computer or other applications; such simultaneous operation of two (or more) of said multiple functionalities open new pathways for miniaturization of devices.

The Inventors

**Dr. Peter Müllner** is a Professor of Materials Science and Engineering at Boise State University. Dr. Müllner’s specialty area is microstructures of crystalline materials. He has worked on the formation and characterization of microstructures, including phase transformations, defect characterization and modeling defect interaction. The objects of study included structural materials (austenitic steel) and functional materials; metals, ceramics, intermetallics and semiconductors; materials in bulk form and thin films.

**Dr. William Knowlton** is a Professor with a joint appointment in the Departments of Materials Science and Engineering (MSE) and Electrical and Computer Engineering (ECE), and co-MSE graduate coordinator at Boise State University. Dr. Knowlton has published over 70 papers in peer reviewed journals or conferences and has two patents. His research activities include device reliability physics, materials characterization, nanofabrication, biomaterials, magnetic materials and molecular electronic devices.