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Phase-Locked Array of Spin Torque Oscillators and Method for Fabrication

Spin torque oscillators (STOs) offer an innovative alternative to microwave power generation and energy efficient computing. However, both applications require phase locking of an array of STOs, which has so far been difficult to accomplish. Additionally, conventional STOs are difficult to couple electrically and magnetically, and they require a large current to induce oscillations. As a result, conventional STOs, based on magnetic tunnel junctions, are capable of generating microwave power, but are not well suited for achieving ultra-low power dissipation. Since phase states require a continuously running oscillator, energy efficient computing is feasible only for oscillators with ultra-low power dissipation. Therefore, there is a need for ultra-low power spin torque oscillators that are capable of generating microwave power, as well as facilitating energy efficient computing.

Researchers at Arizona State University have invented a novel method and structure for arrays of coupled spin torque oscillators ideal for microwave power generation and energy efficient massively parallel computing. The STOs are comprised of highly uniform and spherically symmetric magnetic nanoparticles. This invention offers critical advantages over other proposed approaches for computing with oscillators, including higher energy efficiency, simpler fabrication, higher density, easier scalability, greater design flexibility, more robust logic states, and superior data I/O capability. Additionally, this invention offers advantages over current STO approaches for microwave power generation as the stronger coupling and high STO density produces greater stability.

Potential Applications

- Massively parallel computing
- Big data processing and analysis
- Microwave power generation

Benefits and Advantages

- Increased Energy Efficiency –
  - The high density of nanospheres coupled together (phase-locked) reduces the power requirements when compared to magnetic tunnel junction-based devices.
  - The small size and spherical shape of the nanoparticles allow the oscillations to be achieved at low currents and with ultra-low power dissipation.
- Scalable –
  - Nanoparticle STOs can be precisely organized into highly regular arrays by self-assembly techniques and can be uniformly spaced in close proximity to allow strong electrical and magnetic coupling.

- Fabrication is simplified by the use of a lateral drive current, which allows a simple 2D layout with no upper contacts.

For more information about the inventor(s) and their research, please see

Dr. Richard Kiehl's directory webpage

Dr. Nicholas Rizzo's directory webpage