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Robust Diamond-based RF Switch Yields Enhanced Communication Capabilities (IN-09-053)

Meeting the needs of next-generation military and civilian communication systems

The Invention

Scientists at Argonne National Laboratory have created a special radio frequency (RF) microelectromechanical system (MEMS) switch based on ultrananocrystalline diamond (UNCD) as a dielectric that promises a next generation of military and commercial communication systems with enhanced capabilities. An RF MEMS switch consists of a membrane activated by an electric field applied between the membrane and a bottom electrode covered by a dielectric layer. Integrated with a complementary metal–oxide–semiconductor (CMOS) driving device, the switch enables the simultaneous handling of data, voice, audio, and video while supporting many RF systems operating across a broad range of frequency bands.

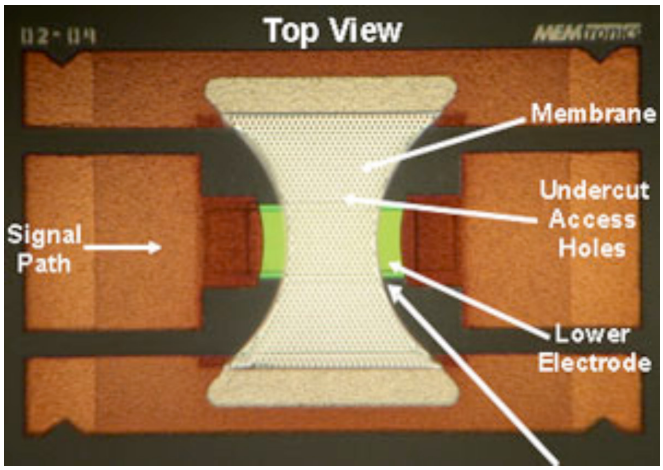
Until recently, RF MEMS switches were introduced in the market as individual components but not integrated with CMOS. Because most RF switches are fabricated by using a variety of technologies, integrating the functions with CMOS has proved too complex and costly. On the other hand, switches using microelectromechanical system technology (MEMS), are shown to provide a single solution that integrates "passive" RF front-end functions with a CMOS chip.

The integration of functions – such as band selection, filters, mixers, frequency references (oscillators), and duplexers – into RF front-end systems generally requires the use of switches and resonators. Typically, this integration is accomplished through the use of expensive, often large components, gallium arsenide switches, on-chip integration with low-Q LC circuits, and active CMOS circuits.

Argonne's invention will meet the next-generation military and civilian communication systems' need for enhanced capabilities. As the numbers of bands and bandwidth requirements increase, a compact radio frequency (RF) system will be essential to counter increases in the size of signal processing and memory chips and to reduce size and cost.

Benefits

- Extremely low power consumption: prevents overcharge and improves safety
- Greater reliability: speed of charging/discharging eliminates the dielectric breakdown that generally occurs with conventional dielectrics over time
- Robust tribological interaction with actuating metal membrane: eliminates adhesion-induced failures
- Intelligent bias control through on-chip CMOS circuitry: allows device to operate 50 times longer than conventional switches



Integrated RF-MEMS capacitive switch based on ultrananocrystalline diamond as a dielectric.

- Very low insertion loss
- Ultrahigh linearity

Applications and Industries

- Military and civilian communications
- Mobile communications and devices

Developmental Stage

Proof of concept

Availability

Available for licensing

Argonne Invention Number

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Patent Information

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