Robert J. (Bruce) Warmack

Experience

Bruce Warmack has had a long career in a variety of experimental physics and sensing technologies. He earned his B.S. in Engineering Physics in 1970 and his Ph.D. in Physics in 1975 at the University of Tennessee. His early fields of activity at Oak Ridge National Laboratory have included studies in transport phenomena, molecular-beam kinetics, electron microscopy, microlithography, and dielectric properties of nanoparticles. In 1985, he pioneered a new laboratory at ORNL for scanning probe microscopy and co-invented the photon scanning tunneling microscope. In 1994, he was recognized by the American Physical Society, citing his work with scanning tunneling microscopy. His group's studies with the atomic-force microscope resulted in the development of microcantilever sensor arrays and were licensed by Graviton, where on entrepreneurial leave he served as Director of MEMS Development from 2000-2002. Dr. Warmack has been actively involved chemical and physical sensing using the full range of technologies from neutron interrogation to practical implementations such as innovative touchscreens and home smoke alarms. He has been awarded various honors, including RD100 Awards, the Fabré-Gramont Award, and is a Fellow of the American Physical Society.

Education

B.S.

Engineering Physics, University of Tennessee, Knoxville, TN, 1970

Ph.D.

Physics, University of Tennessee, Knoxville, TN, 1975

Selected Publications: Over 170 open-literature publications on subjects ranging from organic semiconductors, charge exchange reactions in crossed molecular beams, mass spectrometry, scanning probe microscopy, photoelectrochemistry, MEMS, nanomaterials, and sensor physics.

Hardy J.E., Warmack R.J., Lavrik N., Datskos P.G., Britton C.L. 2009. "Sensor Science for National Security." Baraton MI, Editor. In: *Sensors for Environment, Health and Security: Advanced Materials and Technologies*. p 461-478.

Hafeman, D. G., J. B. Harkins, C. E. Witkowsk, N. S. Lewis, R. J. Warmack, G. M. Brown and T. Thundat (2006). "Optically directed molecular transport and 3D isoelectric positioning of amphoteric biomolecules." *Proceedings of the National Academy of Sciences* **103**(17): 6436–6441.

Warmack, B., K. Korsah and J. Hardy (2005). "A Survey of Commercially Available Humidity and Carbon Dioxide Sensors for Use with Thermally Activated Technologies." ORNL/TM-2005/190.

Britton, C.L., Bryan, W.L., Wintenberg, A.L., Warmack, R.J., McKnight, T.E., Frank, S.S., Cooper, R.G., Dudney, N.J., Veith, G.M., Stephan, A.C. 2004. "A detector for neutron imaging." *IEEE Transactions on Nuclear Science* **51**:1016-19.

Passian, A., R.J. Warmack, T.L. Ferrell, and T. Thundat, "Thermal Transpiration at the Microscale: A Crookes Cantilever." *Physical Review Letters*, 2003. **90**(12): p. 124503-1-4.

Baselt, D.R., B. Fruhberger, E. Klaassen, S. Cemalovic, C.L.B. Jr., S.V. Patel, T.E. Mlsna, D. McCorkle, and B. Warmack, "Design and performance of a microcantilever-based hydrogen sensor." *Sensors and Actuators B: Chemical*, 2003. **88**(2): p. 120-131.

Patents

No. 5,018,865 (May 1991)	"Photon Scanning Tunneling Microscopy"
No. 6,005,400 (Dec. 1999)	"High Resolution Three-Dimensional Doping Profiler"
No. 6,118,124 (Sept. 2001)	"Electromagnetic and nuclear radiation detector using micromechanical sensors"
No. 6,167,748 (Jan. 2001)	"A Capacitively Readout Multielement Sensor Array with Common-Mode Cancellation"
No. 6,289,717 (Sept. 2001)	"Micromechanical antibody sensor"
No. 6,311,549 (Nov. 2001)	"Micromechanical transient sensor for measuring viscosity and density of a fluid"
No. 6,436,346 (Aug. 2002)	"Micro-machined calorimetric biosensors"
No. 6,545,495 (Apr. 2003)	"Method and Apparatus for Self-Calibration of Capacitive Sensors"
No. 6,650,319 (Nov. 2003)	"Touch Screen Based Topological Mapping with Resistance Framing Design"
No. 6,864,692 (Mar. 2005)	"Sensor having improved selectivity"
No. 6,977,511 (Dec. 2005)	"Sensor and sensor array having improved selectivity"
No. 7,243,548 (July 2007)	"Surface wave chemical detector using optical radiation"
No. 7,265,686 (Sept, 2007)	"Touch sensor with non-uniform resistive band"
No. 7,800,589 (Sept. 2010)	"Touch screen with relatively conductive grid"
No. 7,952,564 (May 2011)	"Multiple-Touch Sensor"
No. 8,049,740 (Nov. 2011)	"Method and Apparatus for Laplace Constrained Touchscreen Calibration"
No. 8,425,596 (Apr. 2013)	"Retinal Instrument"
No. 8,591,481 (Nov. 2013)	"Microfabricated Instruments and Methods to Treat Recurrent Corneal Erosion"
No. 8,617,372 (Dec. 2013)	"Array-Type Ammonia Sensor"

Awards

2005	Federal Laboratory Consortium National Award of Excellence in Technology Transfer
2001	Excellence in Technology Transfer
1989 & 1996	R&D 100 Award

1998	Discover Magazine Award for Technological Innovation
1998	Tennessee Technology Award, Consumer Electronics
1988	ORNL Health and Safety Research Division Excellence in Research Award
1986 & 1988	Martin Marietta Energy Systems Inventor's Award
1986, 1988 & 2003	ORNL Significant Event Award
1999	ORNL Development Accomplishment Award
1997	ORNL R&D Achievement Award
1997	ORNL Publication Award
1994	American Physical Society, Division of Biological Physics, **Fellow**
1992	Brussel's World's Fair of Invention Award
1992	International Hall of Fame Advanced Technology Award
1989	Fabré-Gramont Award