

N. V. (Nick) Lavrik

R&D Staff

Nanofabrication Research Laboratory
Center for Nanophase Materials Sciences
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Education

Kiev Polytechnic Institute, Kiev, Ukraine	Electronic Engineering	M.S., 1987
Institute of Semiconductor Physics, Kiev, Ukraine	Physics	Ph.D., 1994

Professional Experience

2007–present	Research Staff Member, Center for Nanophase Materials Sciences, ORNL
2006–2007	Research Staff Member, Nanophotonics Laboratory, Engineering Science and Technology Division, ORNL
2001–2006	Research Assoc., Oak Ridge National Laboratory, Oak Ridge, TN
1999–2001	Postdoctoral Research Associate, University of Tennessee–Knoxville
1996–1999	Postdoctoral Research Associate, University of Illinois, Urbana-Champaign
1988–1996	Research Staff, Institute of Semiconductor Physics, Kiev, Ukraine

Professional and Synergistic Activities

2008– present	Member: Materials Research Society
1998–present	Reviewer for: <i>Nano Letters</i> , <i>Nanotechnology</i> , <i>Applied Physics Letters</i> , <i>Thin Solid Films</i>

Honors and Awards

2012	R&D 100 Award, Broadband Micromechanical Antenna
2011	R&D 100 Award, Nano-Optomechanical Hydrogen Safety Sensor Based on Nanostructured Palladium Layers
2010	R&D 100 Award, Ultrasensitive Nanomechanical Transducers Based on Nonlinear Resonance
2008	ORNL Director's Award, Outstanding Team Accomplishment in Science and Technology
2003	R&D 100 Award, Development of Uncooled IR camera

Publications (Over 60 refereed publications, including 3 invited reviews and 3 book chapters)
Publication list follows CV.

Research Synopsis

1. *Nanoscale photonic and plasmonic structures*

We seek to identify and explore novel fundamental phenomena in nanophotonic and plasmonic structures using a combination of analytical modeling, computational electrodynamics (FDTD method) and newly developed nanofabrication strategies. Of our particular attention are hybrid nanophotonic/plasmonic structures that can be designed to exhibit remarkably strong local field enhancements due to synergetic interactions between dielectric subwavelength resonators and noble metal nanoparticles that possess localized surface plasmon resonances.

2. *Mass transport and separations in nanoscale fluidic systems*

Deterministically created porous media as well as individual channels and pores are excellent model objects for studies of mass transport, separations, and interfacial interactions in the ultimate limit of nanoscale confinement. Using wafer scale technological processes and lithographic patterning, we implement and explore multiscale fluidic structures that can be interrogated optically, electrochemically or electromagnetically. A complementary combination of analytical models and finite element analysis is used to guide our design of our experimental systems.

3. *Nanoscale mechanical phenomena*

We combine analytical, numerical and experimental studies of mechanical phenomena in nanoscale and multiscale structures and aim to identify their unique aspects associated with the reduced dimensionality, nonlinearity and thermally induced fluctuations. Advances in nanofabrication and nanotechnology facilitate fabrication of harmonic and unharmonic oscillators that can be almost arbitrary scaled down approaching the molecular scale. On the other hand, mechanical structures in the upper limit of the nanoscale offer many unique advantages to an experimentalist. Their remarkably high sensitivity to external chemical, electromagnetic and thermal stimuli allows us to create model systems that function as an elegant interface between micro and macro worlds.

Graduate and Postdoctoral Advisors:

Graduate Advisor: Prof. B.A. Nesterenko (Institute of Semiconductor Physics, Kiev, Ukraine)
Postdoctoral Advisors: Dr. Deborah Leckband, University of Illinois-Urbana
Dr. Michael Sepaniak, University of Tennessee-Knoxville
Dr. Panos Datskos, ORNL

Graduate Students Advised: Dragoslav Grbovic, Salva Mostafa (co-advised)

Postdoctoral Scholars Advised: Tim Bannuru. (co-advised)

Publications

Nick V. Lavrik, Ph. D.

Center for Nanophase Materials Sciences

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Over 60 refereed publications, including 4 invited reviews and 3 book chapters

Over 1,600 total cites, H-index=22

20 Most Cited Publications (* 350 or more cites, ** 100 or more cites, * 50 or more cites)**

1. *** Lavrik, N. V.; Sepaniak, M. J.; Datskos, P. G., Cantilever transducers as a platform for chemical and biological sensors. *Review of Scientific Instruments* **2004**, 75, (7), 2229-2253.
2. ** Lavrik, N. V.; Datskos, P. G., Femtogram mass detection using photothermally actuated nanomechanical resonators. *Applied Physics Letters* **2003**, 82, (16), 2697-2699.
3. ** Sivasankar, S.; Briehar, W.; Lavrik, N.; Gumbiner, B.; Leckband, D., Direct molecular force measurements of multiple adhesive interactions between cadherin ectodomains. *Proceedings of the National Academy of Sciences of the United States of America* **1999**, 96, (21), 11820-11824.
4. * Sepaniak, M.; Datskos, P.; Lavrik, N.; Tipple, C., Microcantilever transducers: A new approach to sensor technology. *Analytical Chemistry* **2002**, 74, (21), 568A-575A.
5. * Datskos, P. G.; Lavrik, N. V.; Rajic, S., Performance of uncooled microcantilever thermal detectors. *Review of Scientific Instruments* **2004**, 75, (4), 1134-1148.
6. * Dutta, P.; Tipple, C. A.; Lavrik, N. V.; Datskos, P. G.; Hofstetter, H.; Hofstetter, O.; Sepaniak, M. J., Enantioselective sensors based on antibody-mediated nanomechanics. *Analytical Chemistry* **2003**, 75, (10), 2342-2348.
7. * Tipple, C. A.; Lavrik, N. V.; Culha, M.; Headrick, J.; Datskos, P.; Sepaniak, M. J., Nanostructured microcantilevers with functionalized cyclodextrin receptor phases: Self-assembled monolayers and vapor-deposited films. *Analytical Chemistry* **2002**, 74, (13), 3118-3126.
8. * Singamaneni, S.; LeMieux, M. C.; Lang, H. P.; Gerber, C.; Lam, Y.; Zauscher, S.; Datskos, P. G.; Lavrik, N. V.; Jiang, H.; Naik, R. R.; Bunning, T. J.; Tsukruk, V. V., Bimaterial microcantilevers as a hybrid sensing platform. *Advanced Materials* **2008**, 20, (4), 653-680.
9. Senesac, L. R.; Corbeil, J. L.; Rajic, S.; Lavrik, N. V.; Datskos, P. G., IR imaging using uncooled microcantilever detectors. *Ultramicroscopy* **2003**, 97, (1-4), 451-458.
10. Lavrik, N. V.; Tipple, C. A.; Sepaniak, M. J.; Datskos, P. G., Enhanced chemi-mechanical transduction at nanostructured interfaces. *Chemical Physics Letters* **2001**, 336, (5-6), 371-376.

Additional most recent publications (last three years)

1. Wells, S.M., Merkulov, I.A., Kravchenko, II, Lavrik, N.V., & Sepaniak, M.J. Silicon Nanopillars for Field-Enhanced Surface Spectroscopy. *ACS Nano* **2012**, 6(4):2948-2959.
2. Technique, Culha, M. Cullum, B., Lavrik N.V, and Klutse C. K. Surface-Enhanced Raman Scattering as an Emerging Characterization and Detection (review). *Journal of*

- Nanotechnology* **2012**, article ID. 971380.
3. Taylor, L.C., Kirchner, T.B., Lavrik, N.V., & Sepaniak, M.J. Surface enhanced Raman spectroscopy for microfluidic pillar arrayed separation chips. *Analyst* **2012**, 137(4):1005-1012.
 4. Datskos, P.G., Lavrik, N.V, Tobin, J.D., & Bowland, L.T. Detection of electromagnetic waves using charged cantilevers. *Applied Physics Letters* **2012**, 100(10).
 5. Basore, J.R., Lavrik, N.V., & Baker, L.A. Magnetically gated microelectrodes. *Chemical Communications* **2012**, 48(7):1009-1011.
 6. Alves, F., Kearney, B., Grbovic, D., Lavrik, N.V., & Karunasiri G. Strong terahertz absorption using SiO₂/Al based metamaterial structures. *Applied Physics Letters* **2012**, 100 (11).
 7. Basore, J.R.; Lavrik, N.V.; and Baker, L.A. Magnetically gated microelectrodes. *Chemical Communications* **2012**, 48, (7)1009-1011.
 8. Conley H.; Lavrik N.V.; Prasai, D.; and Bolotin, K.I., Graphene Bimetallic-like Cantilevers: Probing Graphene/Substrate Interactions. *Nano Letters* **2011**, 11, (11) 4748-4752.
 9. Smirnov, S.N.; Vlassiuk, I.V.; and Lavrik, N.V. Voltage-Gated Hydrophobic Nanopores. *ACS Nano* **2011** 5, (9)7453-7461.
 10. Yu, X.; Xiao, K.; Chen, J.; Lavrik, N. V.; Hong, K.; Sumpter, B. G.; Geohegan, D. B., High-Performance Field-Effect Transistors Based on Polystyrene-b-Poly(3-hexylthiophene) Diblock Copolymers. *ACS Nano* **2011**, 5, (5) 3559-3567
 11. Wells, S. M.; Polemi, A.; Lavrik, N. V.; Shuford, K. L.; Sepaniak, M. J., Efficient disc on pillar substrates for surface enhanced Raman spectroscopy. *Chemical Communications* **2011**, 47, (13), 3814-3816.
 12. Vlassiuk, I.; Smirnov, S.; Ivanov, I.; Fulvio, P. F.; Dai, S.; Meyer, H.; Chi, M. F.; Hensley, D.; Datskos, P.; Lavrik, N. V., Electrical and thermal conductivity of low temperature CVD graphene: the effect of disorder. *Nanotechnology* **2011**, 22, (27).
 13. Polemi, A.; Wells, S. M.; Lavrik, N. V.; Sepaniak, M. J.; Shuford, K. L., Dispersion Characteristics in Disk-on-Pillar Array Nanostructures for Surface-Enhanced Raman Spectroscopy. *Journal of Physical Chemistry C* **2011**, 115, (28), 13624-13629.
 14. Lavrik, N. V.; Taylor, L. T.; Sepaniak, M. J., Nanotechnology and chip level systems for pressure driven liquid chromatography and emerging analytical separation techniques: A review. *Analytica Chimica Acta* **2011**, 694, (1-2), 6-20.
 15. Bhandari, D.; Kravchenko, I. I.; Lavrik, N. V.; Sepaniak, M. J., Nanotransfer Printing Using Plasma Etched Silicon Stamps and Mediated by in Situ Deposited Fluoropolymer. *Journal of the American Chemical Society* **2011**, 133, (20) 7722-7724
 16. Taylor, L. C.; Lavrik, N. V.; Sepaniak, M. J., High-Aspect-Ratio, Silicon Oxide-Enclosed Pillar Structures in Microfluidic Liquid Chromatography. *Analytical Chemistry* **2010**, 82, (22), 9549-9556.
 17. Polemi, A.; Wells, S. M.; Lavrik, N. V.; Sepaniak, M. J.; Shuford, K. L., Local Field Enhancement of Pillar Nanosurfaces for SERS. *Journal of Physical Chemistry C* **2010**, 114, (42), 18096-18102.
 18. Basore, J. R.; Lavrik, N. V.; Baker, L. A., Electromagnetic Micropores: Fabrication and Operation. *Langmuir* **2010**, 26, (24), 19239-19244
 19. Lavrik, N. V.; Taylor, L. C.; Sepaniak, M. J., Enclosed pillar arrays integrated on a fluidic platform for on-chip separations and analysis. *Lab on a Chip* **2010**, 10, 1086 - 1094.
 20. Bolakis, C.; Grbovic, D.; Lavrik, N. V.; Karunasiri, G., Design and characterization of terahertz-absorbing nano-laminates of dielectric and metal thin films. *Optics Express* **2010**, 18, (14), 14488-14495.

21. Basore, J.; Lavrik, N.; Baker, L., Single-Pore Membranes Gated by Microelectromagnetic Traps. *Advanced Materials* **2010**,22, (25), 2759–2763.
22. Addae-Mensah, K. A.; Retterer, S.; Opalenik, S. R.; Thomas, D.; Lavrik, N. V.; Wikswo, J. P., Cryogenic Etching of Silicon: An Alternative Method for Fabrication of Vertical Microcantilever Master Molds. *Journal of Microelectromechanical Systems* **2010**, 19, (1), 64-74.

Recent patent applications and invention disclosures selected for patent applications:

1. “Rapid Response Microsensor for Hydrogen Detection Using Responsive Nanostructured Films”, 2011
2. “Nanomechanical Electric and Electromagnetic Field Sensor”, 2010
3. “Nonlinear Nanomechanical Oscillators For Ultrasensitive Inertial Detection”, 2010
4. “Pulsed Photothermal Phase Transformation Control for Titanium Oxide Structures and Reversible Bandgap Shift for Solar Absorption”, 2009