

Alexander A. Puretzky

Senior R&D Staff
Functional Hybrid Group
Center for Nanophase Materials Sciences
Thin Films and Nanostructures Group
Materials Science and Technology Division
Oak Ridge National Laboratory
(865) 241-9482
puretzkya@ornl.gov



Education

Moscow Institute of Physics and Technology, Moscow	Physics and Mathematics	B.S., 1969
Moscow Institute of Physics and Technology, Moscow	Physics	M.S., 1971
Institute of Spectroscopy, Troitsk, Moscow Region	Physics	Ph.D., 1977
Institute of Chemical Physics, Moscow	Physics (Laser Spectroscopy)	Doctorate, 1989

Professional Experience

2006–p Senior Research Staff Member, Center for Nanophase Materials Sciences (CNMS) and Materials Science and Technology Division (MSTD), Oak Ridge National Laboratory (ORNL)

2003–2006 Research Professor, Dept. of Materials Sci. and Engr., Univ. of TN-Knoxville (UTK)

1999–2003 Research Associate Professor, Dept. of Materials Sci. and Engr., (UTK)

1995–1999 Research Scientist, ORNL (via Oak Ridge Associated Universities (ORAU))

1992–1995 Visiting Scientist, ORNL

1989–1992 Science Alliance Professor, Physics (part-time), Inst. Physics and Tech., Moscow, Russia

1971–1992 Research/Sr. Scientist and Group Leader, Inst. of Spectroscopy, Troitsk, Moscow, Russia

Professional and Synergistic Activities

2011 Session Chair, Nucleation & Growth Mechanisms of Single Wall Carbon Nanotubes, 2011 Guadalupe Workshop V, April 8-12, 2011

1995–p Reviewer, Peer-Reviewed Journals: *Physical Review Letters*; *Physical Review B*, *Applied Physics Letters*

Honors and Awards:

1999; 1998 Lockheed Martin Technical Achievement Award

Patents:

“Transparent Conductive Nano-Composites,” D. B. Geohegan, I. N. Ivanov, A.A. Puretzky, S. Jesse, B. Hu, M. Garrett, B. Zhao, U.S. Patent No. 7,923,922 B2, Issued: 4/12/2011.

“Condensed Phase Conversion and Growth of Nanorods and Other Materials Instead of From Vapor,” D. B. Geohegan, R. D. Seals, A. A. Puretzky, X. Fan, U.S. Patent No. 7,815,973 B2, Issued: 10/19/2010.

“Fabrication of High Thermal Conductivity Arrays of Carbon Nanotubes and Their Composites,” D. B. Geohegan, I. N. Ivanov, A. A. Puretzky, U.S. Patent No. 7,763,353 B2, Issued: 7/27/2010.

Recent Invited Talks and Contributed Conference Presentations (Invited*, Contributed**)

“In Situ Optical Diagnostics of Graphene Synthesis,” A. A. Puretzky, D. B. Geohegan, N. Thonnard, J. D. Readle, C. M. Rouleau, G. Eres, M. Regmi, G. Duscher, and M. Yoon, SPIE Photonics West, San Francisco, CA, Jan. 21-26, 2012.**

- “In Situ Diagnostic-Based Modeling of Carbon Nanotube Growth,” A. A. Puzetky et al, Nucleation and Growth Mechanisms of Single Wall Carbon Nanotubes, Guadalupe Workshop V, Bandera, TX, Apr. 8-12, 2011.*
- “In Situ Spectroscopic Diagnostics of SnO₂ Nanowire Growth by Laser-CVD at High Temperatures,” A. A. Puzetky, Junsoo Shin, C. M. Rouleau, J. D. Readle, N. Thonnard, A. Goyal, and D. B. Geohegan, SPIE Photonics West, San Francisco, CA, Jan. 23-27, 2011.**
- “Tunable Raman Spectroscopy at the Center for Nanophase Materials Sciences, Oak Ridge National Laboratory,” A. A. Puzetky, Applications of Raman Microscopy to Nanoscience Workshop, Argonne National Laboratory, Center for Nanoscale Materials, Oct 22-23, 2010.*
- “Pulsed Growth of Vertically Aligned Nanotube Arrays with Variable Density,” A. Puzetky et al, University of California Nanotechnology Workshop, Oct 4, 2010.*

Publications (~ 200 articles in refereed journals and books): Last 5 years publication list follows CV.

Research Synopsis:

1. **Laser Spectroscopy of Nanomaterials.** Tunable Raman scattering, surface enhanced Raman scattering (SERS), and time-resolved photoluminescence spectroscopies are used to study and characterize graphene, single wall carbon nanotubes (SWNTs), oxide, and other nanomaterials.
2. **Synthesis of Nanomaterials.** We use Pulsed Laser Vaporization (PLV) (employing different lasers: excimers, high power Nd:YAG, femtosecond, etc.), Chemical Vapor Deposition (CVD), and pulsed CVD to synthesize different nanomaterials including graphene, carbon nanotubes, carbon nanohorns, nanoparticles, nanowires, and thin films.
3. **Studies of Growth Mechanisms of Nanomaterials in CVD.** We perform real-time measurements of growth kinetics of vertically aligned carbon nanotube arrays and graphene using optical imaging, time-resolved reflectivity, and *in-situ* Raman scattering approaches.
4. **Modeling of Growth Kinetics.** We use kinetic modeling combined with *in situ* diagnostics to understand the growth of nanotube arrays.
5. **Studies of Growth Mechanisms of Nanomaterials in PLV.** *In situ* spectroscopic diagnostics including fast gated ICCD imaging, Rayleigh scattering, absorption, photoluminescence, laser induced luminescence and incandescence, ion probe measurements are used to characterize laser ablation plumes and reveal mechanisms of nanomaterials and thin films growth by PLV.
6. **Matrix Assisted Laser Desorption/Ionization (MALDI).** We use *in-situ* spectroscopic diagnostics and modeling of MALDI biomolecules plumes to understand entrapping of heavy biomolecules into a matrix plume.

Collaborations: B. Burke (Univ. of VA); T. Campbell (Univ. of VA); J. Chan (Univ. of VA); E. Chung (VA Tech); F. Corwin (VA Commonwealth Univ.); T. Do (VA Tech); H. Dorn (VA Tech); A. Esker (VA Tech); P. Fatouros (VA Commonwealth Univ.); T. Fuhrer (VA Tech); J. Ge (VA Tech); R. Gerhardt (GA Tech); H. W. Gibson (VA Tech); S. Henderson (VA Commonwealth Univ.); H. Hu (Chase Corp.); R. Hurt (Brown Univ.); A. Kane (Brown Univ.); I. Kulaots (Brown Univ.); J. Kushmerick (NIST); J. Liu (Brown Univ.); J. Liu (Duke Univ.); X. Liu (Brown Univ.); M. Manson (VA Tech); G. Palmore (Brown Univ.); C. Rylander (VA Tech); M. Rylander (VA Tech); S. Sarkar (VA Tech); S. Sen (Brown U.); C. Shu (VA Tech); G. Singh (VA Tech); M. Shultz (VA Commonwealth Univ.); G. Singh (VA Tech); J. Whitney (VA Tech); K. Williams (U. of VA); T. Young (SUNY Stony Brook); T. Young (VA Tech); D. Yuan (Duke Univ.); C. Zhang (VA Tech); J. Zhang (VA Tech).

Graduate and Postdoctoral Advisors:

Graduate Advisor: Dr. R. V. Ambartzumian Laser Spectroscopy Division, Institute of Spectroscopy, Troitsk (Currently at Lebedev Physics Institute, Moscow, Russia)

Postdoctoral Advisor: Prof. V. S. Letokhov, Institute of Spectroscopy, Troitsk, Moscow, Russia

Thesis Advisor and Postgraduate-Scholar Sponsor:

Students: A. V. Evseev; A. V. Dem'yanenko (Institute of Spectroscopy, Troitsk, Russia)

Postgraduate Scholars (shared):

H. Schittenhelm (Bosch, Germany); H. Hu, B. Zhao (SelahTechnologies); K. Xiao (ORNL); Z. Liu (SiGen); D. Styers-Barnett (Univ. of Indianapolis); J. J. Jeremy (ORNL), J. D. Readle (ORNL)

RECENT PUBLICATIONS
(2007-2011)

Alex A. Puzetzkya
Center for Nanophase Materials Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831
puzetzkya@ornl.gov

Book Chapters

- G. Eres, D. B. Geohegan, A. A. Puzetzkya, and C. M. Rouleau, "All Carbon Nanotubes are not Created Equal," Book Chapter 4 in Nanotechnology for Electronics, Photonics, and Renewable Energy, Springer Series in Nanostructure Science and Technology, pp. 131-152, Eds., A. Korkin, P.S. Krstic, and J.C. Wells, Springer Series in Nanostructure Science and Technology, Springer-Verlag, Berlin Heidelberg (2010).
- D. B. Geohegan, A. A. Puzetzkya, C. M. Rouleau, J. J. Jackson, G. Eres, Z. Liu, D. Styers-Barnett, H. Hu, B. Zhao, K. Xiao, I. Ivanov, and K. More, "Laser Interactions in Nanomaterials Synthesis," Book Chapter 1 in Laser-Surface Interactions for New Materials Production: Tailoring Structure and Properties, Vol. 130, pp. 1-18, Eds., Antonio Miotello and Paolo M. Ossi, Springer Series in Materials Science, Springer-Verlag, Berlin Heidelberg (2010).

Publications

- B. G. Burke, J. Chan, K. A. Williams, T. Fuhrer, W. J. Fu, H. C. Dorn, A. A. Puzetzkya, and D. B. Geohegan, "Vibrational Spectrum of the Endohedral Y(2)C(2)@C(92) Fullerene by Raman Spectroscopy: Evidence for Tunneling of the Diatomic C(2) Molecule," *Physical Review B* **83**(11), 115457 (2011).
- D. B. Geohegan, A. A. Puzetzkya, J. J. Jackson, C. M. Rouleau, G. Eres, and K. L. More, "Flux-Dependent Growth Kinetics and Diameter Selectivity in Single-Wall Carbon Nanotube Arrays," *ACS Nano* **5** (10), 8311 (2011).
- J. R. Whitney, S. Sarkar, J. F. Zhang, D. Thao, T. Young, M. K. Manson, T. A. Campbell, A. A. Puzetzkya, C. M. Rouleau, K. L. More, D. B. Geohegan, C. G. Rylander, H. C. Dorn, and M. N. Rylander, "Single Walled Carbon Nanohorns as Photothermal Cancer Agents," *Lasers in Surgery and Medicine* **43**(1), 43 (2011).
- X. Y. Liu, S. Sen, J. Y. Liu, I. Kulaots, D. Geohegan, A. Kane, A. A. Puzetzkya, C. M. Rouleau, K. L. More, G. T. R. Palmore, and R. H. Hurt, "Antioxidant Deactivation on Graphenic Nanocarbon Surfaces," *Small* **7**(19), 2775 (2011).
- A. A. Puzetzkya, D. B. Geohegan, and C. M. Rouleau, "Narrow and Intense Resonances in the Low-Frequency Region of Surface-Enhanced Raman Spectra of Single-Wall Carbon Nanotubes," *Physical Review B* **82**(24), 245402 (2010).
- B. G. Burke, J. Chan, K. A. Williams, J. C. Ge, C. Y. Shu, W. J. Fu, H. C. Dorn, J. G. Kushmerick, A. A. Puzetzkya, and D. B. Geohegan, "Investigation of Gd(3)N@C(2n) (40 < n < 44) Family by Raman and Inelastic Electron Tunneling Spectroscopy," *Physical Review Letters* **81**(11), 115423 (2010).
- B. G. Burke, J. Chan, K. A. Williams, Z. L. Wu, A. A. Puzetzkya, and D. B. Geohegan, "Raman Study of Fano Interference in P-Type Doped Silicon," *Journal of Raman Spectroscopy* **41**(12), 1759 (2010).
- C. Y. Shu, J. F. Zhang, J. C. Ge, J. H. Sim, B. G. Burke, K. A. Williams, W. M. Rylander, T. Campbell, A. Puzetzkya, C. Rouleau, D. B. Geohegan, K. More, A. R. Esker, H. W. Gibson, and H. C. Dorn, "A Facile High-speed Vibration Milling Method to Water-disperse Single-Walled Carbon Nanohorns," *Chemistry of Materials* **22**(2), 347 (2010).
- J. F. Zhang, J. C. Ge, M. D. Shultz, E. N. Chung, G. Singh, C. Y. Shu, P. P. Fatouros, S. C. Henderson, F. D. Corwin, D. B. Geohegan, A. A. Puzetzkya, C. M. Rouleau, K. More, C. Rylander, M. N. Rylander, H. W. Gibson, and H. C. Dorn, "In Vitro and in Vivo Studies of Single-Walled Carbon Nanohorns with Encapsulated Metallofullerenes and Exohedrally Functionalized Quantum Dots," *Nano Letters* **10**(8), 2843 (2010).

- J. J. Jackson, A. A. Puztzky, K. L. More, C. M. Rouleau, G. Eres, and D. B. Geohegan, "Pulsed Growth of Vertically Aligned Nanotube Arrays with Variable Density," *ACS Nano* **4**(12), 7573 (2010).
- M. P. Garrett, I. N. Ivanov, R. A. Gerhardt, A. A. Puztzky, and D. B. Geohegan, "Separation of Junction and Bundle Resistance in Single Wall Carbon Nanotube Percolation Networks by Impedance Spectroscopy," *Applied Physics Letters* **97**(16), 163105 (2010).
- G. Eres, C. M. Rouleau, M. Yoon, A. A. Puztzky, J. J. Jackson, and D. B. Geohegan, "Model for Self-Assembly of Carbon Nanotubes from Acetylene Based on Real-Time Studies of Vertically Aligned Growth Kinetics," *Journal of Physical Chemistry C* **113**(35), 15484 (2009).
- K. Xiao, A. J. Rondinone, A. A. Puztzky, I. N. Ivanov, S. T. Retterer, and D. B. Geohegan, "Growth, Patterning, and One-Dimensional Electron -Transport Properties of Self-Assembled Ag-TCNQF(4) Organic Nanowires," *Chemistry of Materials* **21**(18), 4275 (2009).
- K. Xiao, R. J. Li, J. Tao, E. A. Payzant, I. N. Ivanov, A. A. Puztzky, W. P. Hu, and D. B. Geohegan, "Metastable Copper-Phthalocyanine Single-Crystal Nanowires and Their Use in Fabricating High-Performance Field-Effect Transistors," *Advanced Functional Materials* **19**(23), 3776 (2009).
- A. A. Puztzky, D. J. Styers-Barnett, C. M. Rouleau, H. Hu, B. Zhao, I. N. Ivanov, and D. B. Geohegan, "Cumulative and Continuous Laser Vaporization Synthesis of Single Wall Carbon Nanotubes and Nanohorns," *Applied Physics A: Materials Science and Processing* **93**(4), 849 (2008).
- C. M. Rouleau, G. Eres, H. Cui, H. M. Christen, A. A. Puztzky, and D. B. Geohegan, "Altering the Catalytic Activity of Thin Metal Catalyst Films for Controlled Growth of Chemical Vapor Deposited Vertically Aligned Carbon Nanotube Arrays," *Applied Physics A: Materials Science and Processing* **93**(4), 1005 (2008).
- K. Xiao, J. Tao, A. A. Puztzky, I. N. Ivanov, S. T. Retterer, S. J. Pennycook, and D. B. Geohegan, "Selective Patterned Growth of Single-Crystal Ag-TCNQ Nanowires for Devices by Vapor-Solid Chemical Reaction," *Advanced Functional Materials* **18**(19), 3043 (2008).
- A. A. Puztzky, G. Eres, C. M. Rouleau, I. N. Ivanov, and D. B. Geohegan, "Real-Time Imaging of Vertically Aligned Carbon Nanotube Array Growth Kinetics," *Nanotechnology* **19**(5), 055605 (2008).
- Z. Liu, D. J. Styers-Barnett, A. A. Puztzky, C. M. Rouleau, D. Yuan, I. N. Ivanov, K. Xiao, J. Liu, and D. B. Geohegan, "Pulsed Laser CVD Investigations of Single-Wall Carbon Nanotube Growth Dynamics," *Applied Physics A: Materials Science & Processing* **93**(4), 987 (2008).
- D. B. Geohegan, A. A. Puztzky, D. Styers-Barnett, H. Hu, B. Zhao, H. Cui, C. M. Rouleau, G. Eres, J. J. Jackson, R. F. Wood, S. Pannala, and J. C. Wells, "In Situ Time-Resolved Measurements of Carbon Nanotube and Nanohorn Growth," *Physica Status Solidi B* **244**(11), 3944 (2007).
- K. Xiao, J. Tao, Z. W. Pan, A. A. Puztzky, I. N. Ivanov, S. J. Pennycook, and D. B. Geohegan, "Single-Crystal Organic Nanowires of Copper-Tetracyanoquinodimethane: Synthesis, Patterning, Characterization, and Device Applications," *Angewandte Chemie International Edition* **46**(15), 2650 (2007).
- M. D. Cheng, D. W. Lee, B. Zhao, H. Hu, D. J. Styers-Barnett, A. A. Puztzky, D. W. DePaoli, D. B. Geohegan, E. A. Ford, and P. Angelini, "Formation Studies and Controlled Production of Carbon Nanohorns using Continuous In Situ Characterization Techniques," *Nanotechnology* **18**(18), 185604 (2007).
- R. Jin, Z. X. Zhou, D. Mandrus, I. N. Ivanov, G. Eres, J. Y. Howe, A. A. Puztzky, and D. B. Geohegan, "The Effect of Annealing on the Electrical and Thermal Transport Properties of Macroscopic Bundles of Long Multi-Wall Carbon Nanotubes," *Physica B* **388**(1-2), 326 (2007).
- R. F. Wood, S. Pannala, J. C. Wells, A. A. Puztzky, and D. B. Geohegan, "Simple Model of the Interrelation Between Single- and Multiwall Carbon Nanotube Growth Rates for the CVD Process," *Physical Review B* **75**(23), 235446 (2007).