Dr. Dmitry A. Kukuruznyak

Director of Research and Development

The Animate Condensed Matter Company

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Date of Birth: May 13, 1971. Nationality: Russian.

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Education

Ph.D. in Materials Science and Engineering from University of Washington, Seattle, WA, USA (2003);
M.S. in Condensed Matter Physics from University of Miami, Coral Gables, FL, USA (1998);
Diplom in Quantum Physics from St. Petersburg State University, St. Petersburg, Russia (1996).

Current employment (2015 – present)

I am designing and implementing a research program aimed at the creation of a new type of artificial intelligence accelerators. Our privately held R&D company was established as a pilot project to prove the viability of a new type of functional materials for physical AI applications. I took part in organizing this project. I have established the lab and developed the research program. Currently, I lead a small team of scientists and engineers. My work combines fundamental science, applied research, and frontier technology development. I design proof of concept experiments and produce device prototypes. I develop fabrication and characterization tools and perform data analysis.

I enjoy being a scientific entrepreneur who is taking scientific research to the marketplace. I can integrate science and business perspectives and transform advanced research into commercial innovation. I have a unique management experience, connecting people from different backgrounds, working across borders, cultures, work ethics, and conflicting business interests and scientific perspectives. The results of my work can be found in this link: physical artificial intelligence.

- **Twenty years of experience in developing novel materials for emerging technologies**
- **Experience in initiating, developing and implementing mid-size research programs**
- **Hands-on experience with start-ups and pilot projects in several different countries**
- **Good knowledge of semiconductor fabrication techniques (research scale)**
- **Expert skills in structural and electric characterization of nanostructures**
- **Many years in fabrication of thin films, multilayers and nanostructures.**

Previous professional experience

Max-Planck Institute for Solid State Research (MPI-FKF), Postdoctoral Researcher (2010 – 2014);
Max-Planck Institute for Intelligent Systems (MPI-IS), Postdoctoral Researcher (2007 – 2010);
National Institute for Materials Science (NIMS), Japan, Postdoctoral Researcher (2003 – 2007).

2010 – 2014   Max-Planck Institute for Solid State Research (MPI-FKF), Stuttgart, Germany. Technology Department. Group leader: Gennady Logvenov.

I fabricated atomically flat $LaAlO_3$/$SrTiO_3$ multilayers and superlattices by Pulsed Laser Deposition (PLD). I fabricated devices from these conducting and insulating thin films, and performed electrical and magnetic measurements. I established relations between their fabrication conditions, structures, and performance characteristics. Expert knowledge of excimer laser – target interaction.

2007 – 2010   Max-Planck Institute for Intelligent Systems (MPI-IS), Stuttgart, Germany. Low dimensional and Functional Materials Department. Group leader: Harald Reichert.

I have designed high dielectric constant (high-*k*) oxide thin films for field-effect transistors: I have discovered a new kind of natural self-constructing epitaxial oxides on silicon. I have established its crystallographic and dielectric properties. I have developed high-throughput structural characterization methods using synchrotron radiation.

Expertise: Synchrotron X-ray diffraction. Epitaxial oxide thin films on Si. Detailed structure & texture analysis of multilayer and composition-spread thin films.

2003 – 2007   National Institute for Materials Science, Advanced Electronic Materials Center, Tsukuba, Ibaraki, Japan. Group leader: Toyohiro Chikyow.

I fabricated combinatorial composition spread thin films by PLD (complete ternary diagram on a single chip). I have developed high-throughput characterization methods for the compounds containing multiple components (Collecting and analyzing big data sets using scanning XRD and scanning conductivity and impedance measurements). I have found ideal epitaxial compositions for thermoelectric and sensors applications.

Expertise: PVD deposition of oxide thin films. High-throughput fabrication and characterization of epitaxial thin films and multilayers. High-throughput characterization and data analysis. Scanning XRD. Scanning electrical measurements.

1999 – 2003   Ph.D. Project. Department of Materials Science and Engineering, University of Washington; Seattle, WA, USA. Advisor: Prof. Fumio S. Ohuchi.

I have designed and fabricated an ultrafast thin film temperature sensor for oceanographic measurements. I have developed a new solution-based method of fabrication of thermistor thin films. I adapted multiple-component spinel oxides for thermistor applications. I have established relations between preparation conditions, electronic properties, conduction, and crystal structure of thermistor ceramics.

Expertise: Conducing thin films and insulating coatings. Ceramics processing. Solution-based thin film fabrication. Vacuum deposition (PVD, E-beam). Structural analysis: SEM; High-resolution TEM. Electronic characterization by XPS, Auger, EELS, and XANES. Quantum-mechanical simulations of EXAFS spectra. Electric measurements and oceanic field tests.

1996 – 1999   Masters Project. Department of Physics, University of Miami; Coral Gables, FL, USA. Advisor: Prof. Joshua A. Cohn.

I fabricated and characterized ferroelectric and magnetoresistant epitaxial barium titanate thin films using Sputtering and Pulsed Laser Deposition. I performed structural characterization of thin films using X-ray diffraction. I carried out magnetic and electrical measurements of the oxide thin films.

1995 – 1996   Undergraduate Project. Faculty of Physics, Quantum Mechanics Department; St. Petersburg, Russia. Advisor: Prof. Yu. D. Demkov.

I performed quantum mechanical calculations and computer simulations in inelastic atomic scattering.

Work results

For the past few years I have been working on a scientific research program aimed at the creation of physical artificial intelligence. It is a new kind of AI, in which a lifelike condensed matter body serves the function of a neural network. The physical AI works much faster than any computer-simulated AI. The results of my work can be found in this link. The prospects for further development of my research and business projects are formulated in this link: Artificial Intelligence farms in Virtual Reality. In greater detail, my scientific and technological accomplishments are described in the following publications:

1. Kukuruznyak, D., The Animate State of Matter Hypothesis. 2020. 〈hal-02913591〉.

2. Kukuruznyak, D., The Physics of Life. Part III: The Artificial Animate Materials. 2020. 〈hal-02541236〉.

3. Kukuruznyak, D., The Physics of Life. Part II: The Neural Network as an Active Condensed Matter Body. 2017. 〈hal-01575993v2〉.

4. Kukuruznyak, D., The Physics of Life. Part I: The Animate Organism as an Active Condensed Matter Body. 2017. 〈hal-01575989v2〉.

Selected publications from earlier projects

5. Hepting, M.; Kukuruznyak, D.; Benckiser, E.; Le Tacon, M.; Keimer, B., Raman light scattering on ultra-thin films of $LaNiO_3$ under compressive strain. Physica B: Condensed Matter 2015**,** 460 (3), 196-198.

6. Vonk, V.; Huijben, J.; Kukuruznyak, D.; Stierle, A.; Hilgenkamp, H.; Brinkman, A.; Harkema, S., Polar-discontinuity-retaining A-site intermixing and vacancies at $SrTiO_3$/$LaAlO_3$ interfaces. *Phys. Rev. B* 2012**,** *85* (4), 045401(1-5).

7. Toyoda, S.; Okabayashi, J.; Komatsu, M.; Oshima, M.; Lee, D. I.; Sun, S. Y.; Sun, Y.; Pianetta, P. A.; Kukuruznyak, D.; Chikyow, T., Effects of Al doping and annealing on chemical states and band diagram of Y_2O_3/Si gate stacks studied by photoemission and x-ray absorption spectroscopy. *J. Vac. Sci. Technol. A* 2010**,** *28* (1), 16-19.

8. Kukuruznyak, D.; Reichert, H.; Ohmori, K.; Ahmet, P.; Chikyow, T., Pliant Epitaxial Ionic Oxides on Silicon. *Adv. Mater.* 2008**,** *20* (20), 3827-3831.

9. Kukuruznyak, D. A.; Reichert, H.; Okasinski, J.; Dosch, H.; Chikyow, T.; Daniels, J.; Honkimaki, V., High-throughput screening of combinatorial materials libraries by high-energy x-ray diffraction. *Appl. Phys. Lett.* 2007**,** *91* (7), 071916(1-3).

10. Komatsu, M.; Yasuhara, R.; Takahashi, H.; Toyoda, S.; Kumigashira, H.; Oshima, M.; Kukuruznyak, D.; Chikyow, T., Crystal structures and band offsets of ultrathin HfO_2-Y_2O_3 composite films studied by photoemission and x-ray absorption spectroscopies. *Appl. Phys. Lett.* 2006**,** *89* (17), 172107(1-3).

11. Moyer, J. G.; Kukuruznyak, D. A.; Nguyen, N.; Prowse, M. S.; Ohuchi, F. S., Thermopower and electrical conductivity of $Mn_{1.68-X}Cu_{0.6+X+Y+Z}Co_{0.24-Y}Ni_{0.48-Z}$ thin film oxides obtained through metal organic decomposition processing. *J. Appl. Phys.* 2006**,** *100* (8), 083504(1-13).

12. Yasuhara, R.; Komatsu, M.; Takahashi, H.; Toyoda, S.; Okabayashi, J.; Kumigashira, H.; Oshima, M.; Kukuruznyak, D.; Chikyow, T., Composition dependence of band offsets for $(LaAlO_3)_{1-x}(Al_2O_3)_x$ gate dielectrics determined by photoelectron spectroscopy and x-ray absorption spectroscopy. *Appl. Phys. Lett.* 2006**,** *89* (12), 122904(1-3).

13. Kukuruznyak, D. A.; Ahmet, P.; Chikyow, T.; Yamamoto, A.; Ohuchi, F. S., Electrical screening of ternary $NiO-Mn_2O_3-Co_3O_4$ composition spreads. *Appl. Surf. Sci.* 2006**,** *252* (10), 3828-3832.

14. Kukuruznyak, D. A.; Moyer, J. G.; Prowse, M. S.; Nguyen, N.; Rehr, J. J.; Ohuchi, F. S., Relationship between electronic and crystal structure in Cu-Ni-Co-Mn-O spinels - Part B: Binding energy anomaly in Cu^{1+} photoemission spectrum. *J. Electron Spectrosc. Relat. Phenom.* 2006**,** *150* (2-3), 282-287.

15. Kukuruznyak, D. A.; Moyer, J. G.; Nguyen, N. T.; Stern, E. A.; Ohuchi, F. S., Relationship between electronic and crystal structure in Cu-Ni-Co-Mn-O spinels - Part A: Temperature-induced structural transformation. *J. Electron Spectrosc. Relat. Phenom.* 2006**,** *150* (2-3), 275-281.

16. Ahmet, P.; Nagata, T.; Kukuruznyak, D.; Yagyu, S.; Wakayama, Y.; Yoshitake, M.; Chikyow, T., Composition spread metal thin film fabrication technique based on ion beam sputter deposition. *Appl. Surf. Sci.* 2006**,** *252* (7), 2472-2476.

17. Kukuruznyak, D. A.; Moyer, J. G.; Ohuchi, F. S., Improved aging characteristics of NTC thermistor thin films fabricated by a hybrid sol-gel-MOD process. *J. Am. Ceram. Soc.* 2006**,** *89* (1), 189-192.

18. Kukuruznyak, D. A.; Ahmet, P.; Chikyow, T.; Yamamoto, A.; Ohuchi, F. S., Combinatorial screening of ternary $NiO-Mn_2O_3-CuO$ composition spreads. *J. Appl. Phys.* 2005**,** *98* (4), 043710(1-4).

19. Kukuruznyak, D. A.; Ahmet, P.; Yamamoto, A.; Ohuchi, F.; Chikyow, T., Combinatorial fabrication and characterization of ternary $La_2O_3-Mn_2O_3-Co_3O_4$ composition spreads. *Jpn. J. Appl. Phys. 1* 2005**,** *44* (8), 6164-6166.

20. Kukuruznyak, D. A.; Miller, J. B.; Gregg, M. C.; Ohuchi, F. S., Fast response thin-film thermistor for measurements in ocean waters. *Rev. Sci. Instrum.* 2005**,** *76* (2), 024905(1-3).

21. Ohuchi, F. S.; Kukuruznyak, D. A.; Chiyow, T., Compositional design and property adjustment of multi-component oxides for thermoelectric applications. *Mater. Sci. Forum* 2005**,** *502*, 3-6.

22. Kukuruznyak, D. A.; Han, S. W.; Lee, M. H.; Omland, K. A.; Gregg, M. C.; Stern, E. A.; Ohuchi, F. S., Controlled coordination and oxidation states of copper and manganese cations in complex nickel-copper-cobalt-manganese oxide thin films. *J. Vac. Sci. Technol. A* 2001**,** *19* (4), 1923-1928.

23. Kukuruznyak, D. A.; Bulkley, S. A.; Omland, K. A.; Ohuchi, F. S.; Gregg, M. C., Preparation and properties of thermistor thin-films by metal organic decomposition. *Thin Solid Films* 2001**,** *385* (1-2), 89-95.

Languages

Fluent Russian and English, basic German and Japanese.

Immigration status

Currently, I am not legally eligible to work in the USA. I need a job offer to obtain the work permit.

Social media profiles

LinkedIn: https://www.linkedin.com/in/dmitry-kukuruznyak-5886bbba/

XING: https://www.xing.com/profile/Dmitry_Kukuruznyak/cv