Curriculum Vitae

Abhishek Sarkar

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Education

06/2016 – 10/2020 **Technische Universität (TU) Darmstadt, Germany**
Ph.D. (Dr.-Ing.) in Material Science and Engineering
With highest honors (*Summa cum Laude*)

07/2014 – 05/2016 **Indian Institute of Technology (IIT) Madras, India**
Master of Technology (M. Tech.) in Metallurgical and Materials Engineering
CGPA: 9.62/10

08/2010 – 06/2014 **National Institute of Technology (NIT) Durgapur, India**
Bachelor of Technology (B. Tech.) in Metallurgical and Materials Engineering

Research Interests

Battery materials: Magnetic materials; Electronic materials; High entropy oxides; Epitaxial thin-films

Professional Experience

09/2023 – ongoing **Indian Institute of Technology Kharagpur, India**
Assistant Professor
Department of Metallurgical and Materials Engineering

Research Experience

10/2020 – 09/2023 **Karlsruhe Institute of Technology (KIT) & TU Darmstadt, Germany**
Postdoctoral Scientific Employee
Host: Prof. Dr.-Ing. Horst Hahn
Project I: Magneto-electronic properties of high entropy oxides (HEOs)
- Tuning magneto-electronic properties of HEOs as the function of chemical disorder & epitaxial straining
- Battery-based electrochemistry-driven tuning of magnetic properties in HEOs

Project II: Cluster-assembled metallic materials
- Exploring structure-property correlations in metastable cluster-matrix nanocomposites

04/2023 – 08/2023 **University of California Irvine, USA**
Visiting Project Specialist
Host: Prof. Dr. Xiaoqing Pan
Materials Research Science and Engineering Centers (MRSEC) Project
- Exploring short-range clustering in complex oxides thin films

06/2016 – 10/2020 **KIT & TU Darmstadt, Germany**
Doctoral Scientific Employee
Guide: Prof. Dr.-Ing. Horst Hahn
Doctoral Thesis: High Entropy Oxides: Structure and Properties
- Introduced the high entropy approach to design rare-earth-transition-metal based perovskites
- Introduced aerosol and wet-chemical based routes for HEOs synthesis
- Discovered and established the use of high entropy materials as electrodes in Li-ion batteries

- Identified the possibility of large and reversible change of band gap in fluorite-HEOs
- Identified the unique magnetic characteristics in perovskite-HEOs
- Elucidated the mechanisms underpinning the observed structure-property relationships in HEOs

Scientific Achievements

2021 **The best doctoral dissertation** in 2020 from the Department of Materials & Geosciences, TU Darmstadt (Freunden der Technischen Universität zu Darmstadt e. V. prize)

2020 **Dean's prize for excellence in research**: Department of Materials & Geosciences, TU Darmstadt

2015 – 2016 **DAAD sandwich scholarship** for pursuing M. Tech project at Karlsruhe Institute of Technology

Review and Editorial Activities

2018 – present **Reviewer** for *Advanced Materials*, *ACS Applied Materials & Interfaces*, *Applied Physics Letters*, *APL Materials*, *Chemistry of Materials*, *Materials Letters*, *Journal of the American Chemical Society*, *Journal of the American Ceramic Society*, *Journal of Alloys and Compounds*, *Journal of the European Ceramic Society*, *Journal of the Materials Chemistry A*, *Journal of Materials Research*, *Nature Communications* and *Scientific Reports* (Publons ID)

2021– present **Invited Guest Editor**: *Frontiers in Energy Research* (2021), *Applied Physics Letters* (2023)

Teaching and Mentoring Experiences

10/2021 – 04/2023 **Lecturer (sole)**, *"Metastable Materials: Structure, Processing and Properties"*, Full semester course (Winter Semester), TU Darmstadt

09/2017 – 09/2023 **Daily supervision** of 1 PhD thesis (KIT-TU Darmstadt), 3 Master's theses (DAAD-IIT Master Sandwich program) and 1 Bachelor thesis (TU Darmstadt)

07/2021 **Lecturer (topic-specific)**, *"High Entropy Ceramics"*, Summer School on Novel Developments in Nanomaterials & Quantum Materials, Nanjing University of Science and Technology (NJUST)

06/2020 **Lecturer (topic-specific)**, *"Magnetic Properties of High Entropy Oxides"*, Sino-German Summer School on Novel Developments on Nanomaterials, KIT-NJUST

07/2019 **Lecturer (topic-specific)**, *"High Entropy Materials"*, Sino-German Summer School on Recent Advancement in Materials Development, Organized by DAAD and KIT, Germany

06/2018 **Lecturer (topic-specific)**, *"High Entropy Oxides"*, INT-HGI International Training Workshop on Synthesis, Characterization and Properties of Novel Nanostructured Materials, held at NJUST

Technical Expertise

Synthesis	Pulsed lased deposition, Aerosol based (flame & nebulized spray pyrolysis), wet chemical (sol-gel and co-precipitation), conventional solid state and mechanochemistry
Hands on characterization expertise	Mössbauer Spectroscopy (lab in-charge), Superconducting Quantum Interference Device (SQUID) magnetometry, Physical Property Measurement System (PPMS), X-ray diffraction (XRD), X-ray reflectometry (XRR), Cyclic voltammetry, Raman Spectroscopy, Galvanostatic charge-discharge battery cycling, Scanning electron microscopy (SEM), Ultraviolet–visible spectroscopy, X-ray absorption spectroscopy and X-ray circular magnetic dichroism (at DESY & BESSY)
Research-based software skills	TOPAS for Rietveld refinement, Igor Pro for Mössbauer spectra analysis, Diamond for crystallographic structural models, Gatan Microscopy Suite for TEM and EELS analysis

Publications Record

Journal articles	**37**
Patents	**1 granted** (Germany), 1 pending (Germany)
Citations	**3650+** (11/2023, Google scholar)
h-index	**23** (11/2023, Google scholar)
Google Scholar	https://scholar.google.de/citations?user=GiYKPPsAAAAJ&hl=de
ResearcherID	G-9975-2019 (Web of Science)

5 Selected Journal Publications

1. **A. Sarkar**, L. Velasco, D. Wang, Q. Wang, G. Talasila, L. de Biasi, C. Kübel, T. Brezesinski, S. S. Bhattacharya, H. Hahn and B. Breitung, *High entropy oxides for reversible energy storage*, **Nature Communications** 9, 3400 (2018), Impact factor: 17.6, **600+ citations**
2. **A. Sarkar**, D. Wang, M.V. Kante, L. Eiselt, V. Trouillet, G. Iankevich, Z. Zhao, S.S. Bhattacharya, H. Hahn, R. Kruk, *High entropy approach to engineer strongly correlated functionalities in manganites*, **Advanced Materials** 35, 2207436 (2023), Impact factor: 32.0
3. **A. Sarkar**, B. Eggert, R. Witte, J. Lill, L. Velasco, Q. Wang, J. Sonar, K. Ollefs, S. S. Bhattacharya, R. A. Brand, H. Wende, F. MF de Groot, O. Clemens, H. Hahn, R. Kruk, *Comprehensive investigation of crystallographic, spin-electronic and magnetic structure of* $(Co_{0.2}Cr_{0.2}Fe_{0.2}Mn_{0.2}Ni_{0.2})_3O_4$*: Unraveling the suppression of configuration entropy in high entropy oxides*, **Acta Materialia** 117581 (2022), Impact factor: 9.2
4. **A. Sarkar**, Q. Wang, A. Schiele, M. R. Chellali, S. S. Bhattacharya, D. Wang, T. Brezesinski, H. Hahn, L. Velasco, B. Breitung, *High–Entropy Oxides: Fundamental Aspects and Electrochemical Properties*, **Advanced Materials** 31, 1806236 (2019), Impact factor: 32.0, **500+ citations**
5. **A. Sarkar**, R. Djenadic, D. Wang, C. Hein, R. Kautenburger, O. Clemens and H. Hahn, *Rare earth and transition metal based entropy stabilised perovskite type oxides*, **Journal of the European Ceramic Society** 9, 2318 (2018), Impact factor: 6.3, **300+ citations**

Journal Publications List

37. Z. Zhao, A.K. Jaiswal, D. Wang, V. Wollersen, Z. Xiao, G. Pradhan, F. Celegato, P. Tiberto, M. Szymczak, J. Dabrowa, M. Waqar, D. Fuchs, X. Pan, H. Hahn, R. Kruk, **A. Sarkar***, *Strain-Driven Bidirectional Spin Orientation Control in Epitaxial High Entropy Oxide Films*, **Advanced Science** 202304038 (2023)
36. **A. Sarkar**, D. Wang, M.V. Kante, L. Eiselt, V. Trouillet, G. Iankevich, Z. Zhao, S.S. Bhattacharya, H. Hahn, R. Kruk, *High entropy approach to engineer strongly correlated functionalities in manganites*, **Advanced Materials** 35, 2207436 (2023)
35. G. Iankevich, **A. Sarkar**, S. Katnagallu, M.R. Chellali, D. Wang, L. Velasco, R. Singh, T. Reisinger, R. Kruk, H. Hahn, *A new class of clustermatrix nanocomposite made of fully miscible components*, **Advanced Materials** 2208774 (2023)
34. Y. Xiu, A. Mauri, S. Dinda, Y. Pramudya, Z. Ding, T. Diemant,**A. Sarkar**, L. Wang, Z. Li, W. Wenzel, M. Fichtner, Z. Zhao-Karger, *Anion Storage Chemistry of Organic Cathodes for High Energy and High Power Density Divalent Metal Batteries*, **Angewandte Chemie** 62, e202212339 (2023)
33. J. Wang, S.L. Dreyer, K. Wang, Z. Ding, T. Diemant, G. Karkera, Y. Ma, **A. Sarkar**, B. Zhou, M.V. Gorbunov, A. Omar, D. Mikhailova, V. Presser, M. Fichtner, H. Hahn, T. Brezesinski, B. Breitung, Q. Wang, *P2-type layered high-entropy oxides as sodium-ion cathode materials*, **Materials Futures** 035104 (2022)
32. S. P. Chilakalapudi, S. Katnagallu, **A. Sarkar**, Penghui Cao, W. Wenzel, H. Hahn, *Energetically deposited cluster assembly of metallic glasses*, **Acta Materialia** 118152 (2022)
31. **A. Sarkar**, B. Eggert, R. Witte, J. Lill, L. Velasco, Q. Wang, J. Sonar, K. Ollefs, S. S. Bhattacharya, R. A. Brand, H. Wende, F. MF de Groot, O. Clemens, H. Hahn, R. Kruk, *Comprehensive investigation of crystallographic, spin-electronic and magnetic structure of* $(Co_{0.2}Cr_{0.2}Fe_{0.2}Mn_{0.2}Ni_{0.2})_3O_4$*: Unraveling the suppression of configuration entropy in high entropy oxides*, **Acta Materialia** 117581 (2022)
30. L. Eiselt, R. Kruk, H. Hahn, **A. Sarkar***, *Hole doped high entropy ferrites: Structure and charge compensation mechanisms in* $(Gd_{0.2}La_{0.2}2Nd_{0.2}Sm_{0.2}Y_{0.2})_{1-x}Ca_xFeO_3$, **International Journal of Applied Ceramic Technology** 1–11 (2022)
29. L. Su, H. Huyan, **A. Sarkar**, W. Gao, X. Yan, C. Addiego, R. Kruk, H. Hahn, X. Pan, *Direct observation of elemental fluctuation and oxygen octahedral distortion-dependent charge distribution in high entropy oxides*, **Nature Communications** 2358 (2022)

28. L. Lin, K. Wang, **A. Sarkar**, C. Njel, G. Karkera, Q. Wang, R. Azmi, M. Fichtner, H. Hahn, S. Schweidler, B. Breitung, *High–Entropy Sulfides as Electrode Materials for LiIon Batteries*, **Advanced Energy Materials** 2103090 (2022)
27. **A. Sarkar**, P. K. Mannava, L. Velasco, C. Das, B. Breitung, S. S. Bhattacharya, R. Kruk, H. Hahn, *Determining role of individual cations in high entropy oxides: Structure and reversible tuning of optical properties*, **Scripta Materialia** 207, 114273 (2022)
26. E. Tóthová, A. Düvel, R. Witte, R.A. Brand, **A. Sarkar**, R. Kruk, M. Senna, K.L. Da Silva, D. Menzel, V. Girman, M. Hegedüs, M. Balá, P. Makreski, S. Kubuki, M. Kauchová, J. Valíek, H. Hahn, V. epelák, *A Unique Mechanochemical Redox Reaction Yielding Nanostructured Double Perovskite Sr_2FeMoO_6 With an Extraordinarily High Degree of Anti-Site Disorder*, **Frontiers in Chemistry**, 846910 (2022)
25. X. Ye, N. Fortunato, **A. Sarkar**, H. Geßwein, D. Wang, X. Chen, B. Eggert, H. Wende, R. A. Brand, H. Zhang, H. Hahn, R. Kruk, *Creating A Ferromagnetic Ground State with T_c Above Room Temperature in A Paramagnetic Alloy Through Nonequilibrium Nanostructuring*, **Advanced Materials**, 202108793 (2022)
24. S. Wollstadt, Y. Ikeda, **A. Sarkar**, S. Vasala, C. Fasel, L. Alff, R. Kruk, B. Grabowski, O. Clemens, *Structural and Magnetic Properties of $BaFeO_{2.667}$ Synthesized by Oxidizing $BaFeO_{2.5}$ Obtained via Nebulized Spray Pyrolysis*, **Inorganic Chemistry**, 60, 15, 1092310933 (2021)
23. K. Wang, Z.-G. Wu, G. Melinte, Z.-G. Yang, **A. Sarkar**, W. Hua, X. Mu, Z.-W. Yin, J.-T. Li, X.-D. Guo, B.-H. Zhong, Christian Kübel, *Preparation of intergrown P/O-type biphasic layered oxides as high-performance cathodes for sodium ion batteries*, **Journal of Materials Chemistry A** 9, 13151-13160 (2021)
22. P.A. Sukkurji, Y. Cui, S. Lee, K. Wang, R. Azmi, **A. Sarkar**, S. Indris, S.S. Bhattacharya, R. Kruk, H. Hahn, Q. Wang, M. Botros, B. Breitung, *Mechanochemical synthesis of novel rutile-type high entropy fluorides for electrocatalysis*, **Journal of Materials Chemistry A** 9, 8998-9009 (2021)
21. **A. Sarkar**, R. Kruk, H. Hahn, *Magnetic properties of high entropy oxides,* **Dalton Transactions** 50, 1973-1982 (2021)
20. J. Wang, Y. Cui, Q. Wang, K. Wang, X. Huang, D. Stenzel, **A. Sarkar**, R. Azmi, T. Bergfeldt, S. S. Bhattacharya, R. Kruk, H. Hahn, S. Schweidler, T. Brezesinski, B. Breitung, *Lithium containing layered high entropy oxide structures*, **Scientific Reports** 18430 (2020)
19. B. Cheng, H. Lou, **A. Sarkar**, Z. Zeng, F. Zhang, X. Chen, L. Tan, K. Glazyrin, H.-P. Liermann, J. Yan, L. Wang, R. Djenadic, H. Hahn, Q. Zeng, *Lattice distortion and stability of $(Co_{0.2}Cu_{0.2}Mg_{0.2}Ni_{0.2}Zn_{0.2})O$ high-entropy oxide under high pressure*, **Materials Today Advances** 8, 100102 (2020)
18. S.P. Singh, R. Witte, O. Clemens, **A. Sarkar**, L. Velasco, R. Kruk, H. Hahn, *Magnetic Tb75Fe25 Nanoglass for Cryogenic Permanent Magnet Undulator*, **ACS Applied Nano Materials** 3, 72817290 (2020)
17. L. Lin, K. Wang, R. Azmi, J. Wang, **A. Sarkar**, M. Botros, S. Najib, Y. Cui, D. Stenzel, P.A. Sukkurji, Q. Wang, H. Hahn, S. Schweidler, Simon, B. Breitung, *Mechanochemical synthesis: route to novel rock-salt-structured high-entropy oxides and oxyfluorides*, **Journal of Materials Science** 55, 1687916889 (2020)
16. **A. Sarkar**, B. Breitung, H. Hahn, *High entropy oxides: The role of entropy, enthalpy and synergy*, **Scripta Materialia** 187, 4347 (2020)
15. R. Witte, **A. Sarkar**, L. Velasco, R. Kruk, R.A. Brand, B. Eggert, K. Ollefs, E. Weschke, H. Wende, H. Hahn, *Magnetic properties of rare-earth and transition metal based perovskite type high entropy oxides*, **Journal of Applied Physics** 127 185109 (2020)
14. **A. Sarkar**, B. Eggert, L. Velasco, X. Mu, J. Lill, K. Ollefs, S.S. Bhattacharya, H. Wende, R. Kruk, R.A. Brand, H. Hahn, *Role of intermediate 4f states in tuning the band structure of high entropy oxides*, **APL Materials** 8, 051111 (2020)

13. J. Wang, D. Stenzel, R. Azmi, S. Najib, K. Wang, J. Jeong, **A. Sarkar**, Q. Wang, P.A. Sukkurji, T. Bergfeldt, M. Botros, J. Maibach, H. Hahn, T. Brezesinski, B. Breitung, *Spinel to rock-salt transformation in high entropy oxides with Li incorporation*, **Electrochem** 1, 60-74 (2020)
12. B. Breitung, Q. Wang, A. Schiele, Đ. Tripkovic, **A. Sarkar**, L. Velasco, D. Wang, S.S. Bhattacharya, H. Hahn, T. Brezesinski, *Gassing Behavior of High-Entropy Oxide Anode and Oxyfluoride Cathode Probed Using Differential Electrochemical Mass Spectrometry*, **Batteries & Supercaps** 3, 4 (2020)
11. B. Cheng, H. Lou, **A. Sarkar**, Z. Zeng, F. Zhang, X. Chen, L. Tan, V. Prakapenka, E. Greenberg, J. Wen, R. Djenadic, H. Hahn, Q. Zeng, *Pressure-induced tuning of lattice distortion in a high-entropy oxide*, **Communications Chemistry** 2, 114 (2019)
10. **A. Sarkar**, Q. Wang, A. Schiele, M. R. Chellali, S. S. Bhattacharya, D. Wang, T. Brezesinski, H. Hahn, L. Velasco, B. Breitung, *High–Entropy Oxides: Fundamental Aspects and Electrochemical Properties*, **Advanced Materials** 31, 1806236 (2019), **500+ citations**
9. Q. Wang, **A. Sarkar**, D. Wang, L. Velasco, R. Azmi, S. S. Bhattacharya, T. Bergfeldt, A. Düvel, P. Heitjans, T. Brezesinski, H. Hahn, B. Breitung, *Multi-anionic and -cationic compounds: new high entropy materials for advanced Li-ion batteries*, **Energy & Environmental Science** 12, 2433 (2019)
8. R. Witte, **A. Sarkar**, R. Kruk, B. Eggert, R. Brand, H. Wende, H. Hahn, *High-entropy oxides: An emerging prospect for magnetic rare-earth transition metal perovskites*, **Physical Review Materials** 3, 034406 (2019)
7. M. R. Chellali, **A. Sarkar**, S. H. Nandam, S. S. Bhattacharya, B. Breitung, H. Hahn and L. Velasco, *On the homogeneity of high entropy oxides: An investigation at the atomic scale*, **Scripta Materialia** 166, 58 (2019)
6. Q. Wang, **A. Sarkar**, Z. Li, Y. Lu, L. Velasco, S. S. Bhattacharya, T. Brezesinski, H. Hahn, B. Breitung, *High entropy oxides as anode material for Li-ion battery applications: A practical approach*, **Electrochemistry Communications** 100, 121 (2019)
5. **A. Sarkar**, L. Velasco, D. Wang, Q. Wang, G. Talasila, L. de Biasi, C. Kübel, T. Brezesinski, S. S. Bhattacharya, H. Hahn and B. Breitung, *High entropy oxides for reversible energy storage*, **Nature Communications** 9, 3400 (2018), **600+ citations**
4. **A. Sarkar**, R. Djenadic, D. Wang, C. Hein, R. Kautenburger, O. Clemens and H. Hahn, *Rare earth and transition metal based entropy stabilised perovskite type oxides*, **Journal of the European Ceramic Society** 9, 2318 (2018), **300+ citations**
3. **A. Sarkar**, C. Loho, L. Velasco, T. Thomas, S. S. Bhattacharya, H. Hahn and R. Djenadic, *Multicomponent equiatomic rare earth oxides with a narrow band gap and associated praseodymium multivalency*, **Dalton Transactions**, 46, 12167 (2017), **200+ citations**
2. R. Djenadic, **A. Sarkar**, O. Clemens, C. Loho, M. Botros, V. S. K Chakravadhanula, C. Kübel, S. S. Bhattacharya, A. S. Gandhi, and H. Hahn, *Multicomponent equiatomic rare earth oxides*, **Materials Research Letters** 5, 102 (2017), **250+ citations**
1. **A. Sarkar**, R. Djenadic, J. N. Usharani, K. Sanghvi, V. S. K Chakravadhanula, A. S. Gandhi, H. Hahn, S. S. Bhattacharya, *Nanocrystalline multicomponent entropy stabilised transition metal oxides*, **Journal of the European Ceramic Society** 37, 747 (2017), **250+ citations**

Patents

2. Q. Wang, **A. Sarkar**, B. Breitung and H. Hahn, *Single-phase connection, method of its manufacture and electrode*, **DE102018010074B4**, Granted on 24.12.2020
1. B. Breitung, **A. Sarkar**, T. Brezesinski, L. Velasco and H. Hahn, *Electrode material, process for its preparation and its use*, **DE102018100928A1**, Filed on 17.01.2018

Selected Conferences and Workshops

7. **A. Sarkar**, R. Witte, R. Brand, R. Kruk and H. Hahn, *Magnetic properties of high entropy oxides*, *MS&T20 VIRTUAL, Materials Science & Technology*, 2–6 November, 2020, Invited talk

6. **A. Sarkar**, Q. Wang, B. Breitung, and H. Hahn, *High entropy oxides characterized by Ga-jet XRD, STOE User Meeting 2019*, 6–7 September, 2019, *Darmstadt* (Germany), Invited talk
5. **A. Sarkar**, *Recent developments on High Entropy Oxides, Indo-German Workshop On Recent Advances in Nanoscience and Nanotechnology*, March 25–27, 2019, *Chennai* (India), Oral presentation
4. **A. Sarkar**, L. Velasco, B. Breitung, S. S. Bhattacharya and H. Hahn, *High entropy oxides with tailorable properties- Fundamental aspects and prospects, European Materials Research Society (E-MRS)*, 17–20 September 2018, *Warsaw* (Poland), Invited talk
3. **A. Sarkar**, L. Velasco, D. Wang, G. Talasila, L. de Biasi, T. Brezesinski, S. S. Bhattacharya, H. Hahn and B. Breitung, *Electrochemical properties of transition metal based high entropy oxides, European Materials Research Society (E-MRS)*, 18–22 June 2018, *Strasbourg* (France), Oral presentation
2. **A. Sarkar**, R. Djenadic and H. Hahn *Multicomponent equiatomic rare earth oxides, 12th Conference for Young Scientists in Ceramics, CYSC-2017*, October 18-21, 2017, *Novi Sad* (Serbia), Oral presentation
1. **A. Sarkar**, R. Djenadic, M. Shams, M. Brotos, O. Clemens, S. Lebedkin, T. Thomas, S. S. Bhattacharya and H. Hahn, *Multicomponent equiatomic oxides, European Materials Research Society (E-MRS)*, 19–22 September 2016, *Warsaw* (Poland), Oral presentation