

# Abid Hussain, Ph.D.

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## Current Position

Aug. 2023–Till date 📌 Assistant Prof. (Adhoc.) at University of Ladakh

## Education

- 2018 – 2023 📌 **Ph.D. Physics, Inter-University Accelerator Center, New-Delhi, 110067, India**  
Specialization: Materials Science.  
Thesis title: "**Radiation Response of Single-Phase Multicomponent Transition Metal Based Alloys**"
- 2014 – 2016 📌 **M.Sc. Physics, Department of Physics & Astrophysics, University of Delhi, New-Delhi, 110007 India .**  
Specialization: *Laser and Spectroscopy.*
- 2012 – 2014 📌 **B.Sc.(Hons.) Physics, Department of Physics, Aligarh Muslim University, UP, 202002, India**  
Major Subjects: *Physics, Mathematics and Chemistry.*

## Research Experience

- 📌 **Bulk Sample Preparations:** I have optimized the fabrication of NiCoCrFePd high entropy alloy (HEA) and NiCoCrFe medium entropy alloys (MEA) samples using the Arc melting technique. The quasi-random structure is used to analyse the FCC phase of NiCoCrFePd and NiCoCrFe using the Rietveld refinement process. During the alloy preparation I have gained expertise in operating the Arc Melting, Cold Rolling, Diamond Wheel Cutting, and Polishing Machine.
- 📌 **Thin Film Preparations:** I have used very rigorously the E-beam evaporation to deposit the thin film of NiCoCrFePd HEA. In addition, I have also used RF/DC sputtering system to deposit thin films of ZrO<sub>2</sub>, and SiO<sub>2</sub>
- 📌 **TEM, SEM, RBS and AFM:** The depth dependent distribution of elemental information in NiCoCrFePd thin film is evaluated by the Rutherford backscattering scattering (RBS) and analysed using the *XRUMP* and *SIMNRA* simulations. The surface modification by the ion beam is traced out the application both scanning electron microscopy (SEM) and atomic force microscopy (AFM). To target the ion beam modified region and to identify the types of defects produced by the ion irradiation/implantation in bulk as well as thin film samples, the planner and cross-sectional TEM samples are prepared using the twin-Jet electropolishing methods and the Gatan, precision ion polishing system (PIPS) followed by application of the transmission electron microscopy (TEM).
- 📌 **Positron Annihilation Spectroscopy:** The Doppler's broadening spectroscopic and life-time spectroscopic measurements was applied to identify the damage produced by the ion beam irradiation at various fluence and temperatures. The VEPFIT and PALSFit software's used to fit the positron spectra's and to extract the defect information.

## Research Experience (continued)

- **Magnetotransport Properties:** The low-temperature phase stability of the HEAs particularly NiCoCrFePd bulk and thin film is investigated by employing the Crystat XRD measurement down to 15 K temperatures. The magnetic transition, transport behaviour, and their dependence on the annealing temperature of the thin films of NiCoCrFePd HEA are investigated using the physical property measurement system vibrating sample magnetometry (PPMS-VMS) system.
- **Temperature-dependent Irradiation:** I have carried out irradiation of bulk NiCoCrFePd HEA at high temperature 773 K as well as at low temperature 77 K to simulate the effect of temperature-dependent irradiation environments. The phase stability after irradiation was investigated using the XRD measurements. The high temperature-dependent defect formation in NiCoCrFePd thin films is investigated using 500 keV Xe<sup>+3</sup> irradiation at temperatures 273 K, 373 K and 473 K.
- **Irradiation and Analysis:** The ion irradiation using the high energy beam of 120 MeV Au<sup>+9</sup>, 100 MeV Ag<sup>+7</sup>, and low energy beam of 1.05 MeV Xe<sup>+2</sup>, 500 keV Xe<sup>+3</sup> to investigate the structural integrity and performance of high entropy alloys system for bulk sample and thin film sample. The Bruker D8 Advanced XRD machine was used rigorously to investigate the phase of the bulk samples and the thin film samples before and after the ion irradiation process. To further in-depth structural information are extracted by carrying out the synchrotron XRD of 17.4 keV X-ray energy at beam Line 12, Raja Ramanna Centre for Advanced Technology (RRCAT) and the local structure information is investigated using X-ray absorption fine structure spectroscopy (EXAFS) at Fe, Cr, and Pd K-edges was also carried out in the beam line-9 at (RRCAT), Indore, India. Rigorous use of Scanning electron microscopy and Transmission electron microscopy available at IUAC for the microstructural characterization of the pristine and irradiated specimens. Positron annihilation spectroscopy (PAS) available at Baba Atomic Research Centre (BARC) Mumbai was used as a tool for defect quantification. The formation of Various defect microstructures at different ion fluences is correlated with the positron annihilation investigation of defects. Further, I also have a strong experimental hand in performing the mechanical hardening properties of the bulk using the nano-indentation system. The dynamics of the defects is further correlated with the variation in the mechanical properties like the hardening after ion irradiation using the Universal Nanomechanical tester (ASMEC, Germany). Similarly, I also have work experience of the XRD measurement in hydrogen environments for MoS<sub>2</sub>, WS<sub>2</sub> materials for hydrogen sensing applications.

## Research Skills

- **Low Temperature XRD Setup:** Working and refunctionalizing of the He cryostat system with the D8 advanced XRD system to make low-temperature XRD measurement possible down to 15 K in the beam hall-2 at IUAC.
- **High Temperature Irradiation Setup:** I have designed and fabricated a high-temperature setup for high temperature irradiation up to 500 K in the Low-Energy Ion Beam Facility (LEIBF) at IUAC.
- **Hydrogen Sensing XRD set up:** Operational experience in the measurement of XRD in the hydrogen environment 5% at different pressure using the in-situ XRD machine available at the beam line-2 IUAC.
- **Arc Melting & Ball Milling:** Operational experience in Arc melting systems and high-energy ball milling systems.
- **TEM sample preparation & Characterization:** Operational experience in cross-sectional as well as planar sample preparation and TEM characterization.
- **SEM Characterization:** Operational experience in SEM for microstructural characterization.
- **Mechanical Characterization:** Experience in operating the nano-indentor machine for hardness measurement.
- **Coding:** C++, FORTRAN, MATLAB and LaTeX.

## Research Skills (continued)

- **Softwares/Simulations** SRIM/TRIM for radiation damage simulation, Full proof software for XRD analysis, DEMETER software for EXAFS analysis, SIMNRA and RUMP for RBS analysis, Crystbox and ImageJ for TEM and SEM image analysis.
- **Misc.:** Academic research paper writing, journal communication, and presentations.

## Presentations in International Conferences

- 6 – 8, November 2019     ▪ 5th International Conference on Nanostructuring by ion beams, IGCAR, Tamil Nadu, India.
- 4 – 8, October 2021     ▪ Joint ICTP-IAEA Virtual Workshop on Atomistic Modelling of Radiation Damage in Nuclear Systems, Italy.
- 19 – 21, February 2022     ▪ 15th Annual International Workshop on Advanced Materials, United Arab Emirates.
- 22 – 26, August 2022     ▪ 19th International Conference on Positron Annihilation, Helsinki, Finland.
- 16 – 19, November 2022     ▪ 7th International Conference on Ion Beams in Materials Engineering and Characterization, IUAC, New Delhi, India.
- 8 – 10, February 2023     ▪ International Conference on Electron Microscopy & XLI Annual Meeting of Electron Microscope Society of India, Delhi University, New Delhi, India.
- 25 – 29, May 2023     ▪ Nanotechnology for Better Living Srinagar, J&K, India.

## Research Publications

### Journal Articles

- 1 S. K. Sharma, V. Grover, R. Shukla, **Hussain, Abid**, A. Mishra, and P. K. Kulriya, "Response of nonstoichiometric pyrochlore composition  $\text{Nd}_{1.8}\text{Zr}_{2.2}\text{O}_{7.1}$  to electronic excitations," *Journal of the American Ceramic Society*, vol. 107, no. 1, pp. 561–575, 2024. DOI: <https://doi.org/10.1111/jace.19454>.
- 2 **Hussain, Abid**, R. Dhaka, H. J. Ryu, S. K. Sharma, and P. K. Kulriya, "A critical review on temperature dependent irradiation response of high entropy alloys," *Journal of Alloys and Compounds*, p. 169 624, 2023. DOI: <https://doi.org/10.1016/j.jallcom.2023.169624>.
- 3 **Hussain, Abid**, S. Khan, S. K. Sharma, *et al.*, "Influence of defect dynamics on the nanoindentation hardness in nicocrfepd high entropy alloy under high dose  $\text{xe}+3$  irradiation," *Materials Science and Engineering: A*, vol. 863, p. 144 523, 2023. URL: <https://doi.org/10.1016/j.msea.2022.144523>.
- 4 N. Saxena, R. Sharma, **Hussain, Abid**, *et al.*, "Effect of the triple (al, ga, in) doping in zno nanostructures on its transmission, conductivity, and stability for tco applications," *Materials Letters*, vol. 306, p. 130 886, 2022. URL: <https://doi.org/10.1016/j.matlet.2021.130886>.
- 5 S. K. Sharma, V. Grover, R. Shukla, A. **Hussain, Abid** Mishra, R. Meena, and P. K. Kulriya, "Evidence of improved tolerance to electronic excitation in nanostructured  $\text{Nd}_2\text{Zr}_2\text{O}_7$ ," *Journal of Applied Physics*, vol. 129, no. 11, 2021. DOI: <https://doi.org/10.1063/5.0039390>.

### Books and Chapters

- 1 W. Ashraf, M. Khanuja, **Hussain, Abid**, and P. Kulriya, *Functional 2D Nanomaterials for Selective Detection/Sensing of Hydrogen Gas: An Overview*. CRC Press, 2022, pp. 185–207.

## Awards and Achievements

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- 2021    **Best Poster Presentation Award**, at Joint ICTP-IAEA Virtual Workshop on Atomistic Modelling of Radiation Damage in Nuclear Systems, (04-08) October 2021. (Prize money 200 Euros)
- 2022    **2nd Best Poster Presentation Award**, at 7<sup>th</sup> International Conference on Ion Beams in Materials Engineering and Characterization (IBMEC),(16-19) November 2022. (Prize money 1500 Rupees)
- 2023    **Consolation Best Poster Presentation Award**. at International Conference on electron microscopy & XLI annual meeting of electron microscope society of India (EMSI). (08-10) February 2023.

### Fellowships Awarded

- 2016    **Graduated aptitude test for engineering, (GATE) All India Rank, 1715**
- 2017    **Joint CSIR-UGC Junior Research Fellowship & Eligibility for Lectureship (NET) Exam, qualified All India Rank, 347**
- State Eligibility Test (SET) of J& K, qualified**
- 2018    **Joint CSIR-UGC Junior Research Fellowship & Eligibility for Lectureship (NET) Exam, qualified All India Rank, 247**

## References

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### **Prof. Pawan K. Kulriya**

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### **Dr. Saif A. Khan**

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