

A.2: Utilization activities of Indus beamlines

Indus-1 and Indus-2 are national facilities which have been attracting a large number of researchers from all over the country. The initial one half months of the period from July 2020 to December 2020 saw very little user work due to the startup activities at the Indus-1 and Indus-2 machines after the COVID-19 related shutdown. As we did not have any user from outside Indore coming to Indus beamlines for the experiments, almost all the user samples that were analyzed were received by mail. The total number of user experiments that were carried out at the Indus-1 and Indus-2 beamlines in this period was 345. These include a few users from the industry, who have used the EXAFS and XRD beamlines.

During this period, about 75 papers were published in peer reviewed international journals. The topics covered in these publications cover a diverse range of disciplines, namely: materials science, biology, chemistry, nanoparticles, industrial applications, etc. Some of the interesting research results that have been published in the above period are summarized below.

One of the important class of materials that have been studied include energy materials. Electrochemical activity in nanostructured transition metal tellurates $\text{Co}_{1-x}\text{Ni}_x\text{TeO}_4$ ($x = 0, 0.5, \text{ and } 1$) has been studied as a function of charging and discharging cycles to judge the suitability of this new material for energy storage applications. (Ref: Akhilesh Kumar Patel et al., ACS Appl. Energy Mater., Vol. 3, p 9436 (2020)). In another work, the charging and discharging characteristics of 2-H MoTe₂ as anodes in a Li ion cell has been studied and reported. (Ref: Manas Ranjan Panda et al., Small, Vol. 16, p2002669, (2020)). In-situ modulation of silica-supported MoO₂/Mo₂C heterojunction has been studied to understand the role of solid-solid interface for enhancing hydrogen evolution reaction. (Ref: Rajinder Kumar et al., Catal. Sci. Technol., Vol.10, p4776 (2020)).

Other materials that have possible applications for future device applications have also been studied. Some of the interesting publications include a study of the role of local structure of O in implanted ZnO nanowires in determining the field emission characteristics of ZnO nanowires. (Ref: Avanendra Singh et al., J. Appl. Phys., Vol. 128, p054304 (2020)). Structural and optical properties of transparent, tunable bandgap semiconductor $\alpha\text{-(Al}_x\text{Cr}_{1-x})_2\text{O}_3$ have been studied to determine its suitability as p-type transparent semiconductor for solar cell and other transparent optoelectronic device applications. (Ref: Ravindra Jangir et al., J. Appl. Phys., Vol.128, p135703 (2020)). X-ray reflectivity and x-ray photoelectron spectroscopy studies on reactively sputtered Nb₂O₅ as a gate dielectric in thin film devices have been studied and published. (Ref: Karimul Islam et al., SN Applied Sciences, Vol. 2, p782 (2020)). Studies on zeolitic imidazolate frameworks (ZIFs) to understand the role of Zn composition and micrometer scale pore-interconnectivity for its application as a low k-dielectrics have been reported.

(Ref: S.K. Sharma et al., Microporous and Mesoporous Mat., Vol. 307, p110519 (2020)). The optical properties of Ni films in the soft x-ray region of the spectrum for applications in development of x-ray waveguide based optics has been studied and reported. (Kiranjot et al., J. Sync. Rad., Vol. 27, p1633 (2020)). In continuation of this work, the asymmetry in the AlN/Ni and Ni/AlN interfaces have also been analysed and reported (Ref: Kiranjot et al., App. Surf. Sci., Vol. 529, p147199 (2020)). Large positive magneto-resistance in CrSi driven by Cr 3d localization in the valence band, which have possible applications in the development of spintronic devices have been studied. (Ref: Sci. Rep., Vol.10, p12030 (2020)).

The structural changes in pure V and V-4Cr-4Ti alloy with Ar ion irradiation has been studied. These materials are one of the possible candidate structural material for fusion reactor application. (Ref: Fusion Engg. and Design, Vol. 154, p111518 (2020)). The properties of some transition metal borides, which are known to be extremely hard materials and have applications in high pressure, high temperature, acidic and radiation environments, have been studied. (Ref: A.N. Arpita Aparajita et al., Journal of Physics and Chemistry of Solids Vol. 146, p109603 (2020)). Structural phase transition, equation of state and phase diagram of functional rare earth sesquioxide ceramics (Eu_{1-x}La_x)₂O₃ have also been reported. (Ref: K. A. Irshad et al., Sci. Reps., Vol. 10, p11829 (2020)).

Among some work on fundamental understanding of condensed matter related phenomenon, the existence of exchange bias and Griffith phase in (Tb_{1-x}Ce_x)MnO₃ have been studied and correlated with the presence of mixed charge Mn ions in the system. (Ref: Surajit Ghosh et al., Journal of Magnetism and Magnetic Materials, Vol. 500, p166261 (2020)).

The x-ray response of the solar x-ray monitor used in the Chandrayaan-2 Orbiter was carried out at the Indus beamlines. This work, which has high national importance, has also been published. (Ref: N.P.S. Mithun et al., Solar Phys., Vol. 139, p295 (2020)).

Some of the interesting applications related to biology and health that have been published include the following: The effects of magneto-priming on arsenic stress induced leaves have been studied using phase contrast imaging and published (Ref: Anis Fatima et al., Physiologia Plantarum, (2020), doi:10.1111/ppl.13211). The structure of LonNTD like protein from X.-campestris (XCC3289), was determined and found to contain two domains (N terminal and a C terminal) joined by a long loop, which can help in understanding certain protein-protein interactions (Ref: Rahul Singh et al., Acta Cryst, Vol. F76, p488 (2020)).

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