

## A.2: Brief report on Indus beamline utilization

Indus-1 and Indus-2 are national facilities, which have been attracting a large number of researchers from all over the country. Users from the Indian industry have also been regularly using the Indus beamlines. During the period of January to June 2022, the total number of user experiments (including industry users) that were carried out at the Indus-1 and Indus-2 beamlines was 474.

During this period, about 57 papers were published in peer reviewed international journals. This number is significantly smaller due to reduced work at the beamlines in years 2020 and 2021 due to COVID-19 pandemic. 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. The structure of NiO,  $\beta$ -Ni(OH)<sub>2</sub>/Co<sub>3</sub>O<sub>4</sub> nanosheets, and Co<sub>3</sub>O<sub>4</sub> nanorod materials, that have potential in supercapacitors, catalysis and anodes in lithium batteries, have been reported (Ref: U. P. Gawai et al., ACS Omega Vol. 7, p 6700 (2022)). The role of structure and disorder in enhancing the functional properties of V<sub>0.6</sub>Ti<sub>0.4</sub> alloy superconductor by the addition of yttrium has been published (Ref: S. K. Ramjan et al., J. Appl. Phys. Vol. 131, p 063901 (2022)). The evolution of secondary metallic phases in off-stoichiometric ZrNiSn half Heusler alloys for enhanced thermoelectric performance has been carried out and published (Ref: Kishor Kumar Johari et al., ACS Appl. Mater. Inter. Vol. 14, p 19579 (2022)). The impact of atomic rearrangement and single atom stabilization on MoSe<sub>2</sub>-NiCo<sub>2</sub>Se<sub>4</sub> heterostructure catalyst for efficient water splitting has been published (Ref: A. Majumdar et al., Small, Vol. 18, p 2200622 (2022)). The local atomic arrangement in Iron-Lithium-Calcium-Silicate glass and its devitrified state has been determined using EXAFS and complemented by neutron scattering data (Ref: Manjunath T. Nayak et al., Silicon (2022) <https://doi.org/10.1007/s12633-022-01789-2>). Nano-scale physicochemical attributes and their impact on pore heterogeneity in shale have been analysed by computer aided X-ray tomography. (Ref: D. Chandra et al., Fuel, Vol. 314, p 123070 (2022)).

There have been extensive work on applied materials that have potential for future device applications. Some of these are summarized below: Considering the importance of multi-functional properties like pyro, piezo and ferroelectricity in triglycine sulfate (TGS) crystals, gamma irradiation induced crystal imperfections were assessed through the high resolution XRD measurement to understand the development of non-uniform strain in TGS crystals on irradiation (Ref: V. C. Bharath Sabarish et al., J. Mol. Struct., Vol. 1248, p 131450 (2022)).

The correlation of the dielectric properties in BaZrTiO<sub>3</sub>, and its structure determined using temperature dependant XRD complemented with TEM and pair distribution analysis has been published (Ref: K. Dey et al., Phys. Rev. B, Vol. 105, p 174202 (2022)). Effect of Mn doping on the structural, spectral, electrical, ferromagnetic and piezoelectric properties of 0.7BFO-0.3BTO lead-free ceramics has been studied (Ref: F. Jabeen et al., J. Alloys and Comp., Vol. 917, p 165303 (2022)). Tuning the giant magnetocaloric effect in MnCoGe alloy with external pressure was studied for possible applications in refrigeration (Ref: V. K. Sharma et al., AIP Advances, Vo. 12, p 035107 (2022)). The high pressure structural properties of the technologically important rare-earth tantalate EuTaO<sub>4</sub>, which has potential applications in the field of proton conducting solid oxide fuel cells, scintillating crystals and nuclear waste immobilization industry was reported (Ref: S. Banerjee et al., J. Phys.: Condens. Matter, Vol. 34, p 135401 (2022)). Study of interface reaction in a B<sub>2</sub>C/Cr mirror at elevated temperature using soft X-ray reflectivity for applications in high radiation and heat resistant optics at XFELs, 4<sup>th</sup> generation SR sources etc. (Ref: M. H. Modi et al., J. Synch. Rad., Vol. 29, p 978 (2022)).

In the area of studies on strategic materials, the work on using a combination of synchrotron X-ray diffraction, Mossbauer spectroscopy and TEM, very low amounts of austenitic phase in ferritic martensitic (RAFM) 9Cr steels, which are candidate materials for the test blanket module (TBM) of nuclear fusion reactors, has been published (Ref: R. Mythili et al., Symmetry, Vol. 14, p 196 (2022)).

There have also been some interesting work related to the use of synchrotron facilities to develop new and improved analysis techniques. A novel approach for determination of the packing fraction of strongly correlated nano-ellipsoids in a microsphere using small-angle scattering has been reported (Ref: A. Das et al., Langmuir, Vol. 38, p 3832 (2022)). A quantitative approach has been established to obtain elemental detection limits in the range of ng g<sup>-1</sup> by using simple SR based EDXRF excitation (45°–45° geometry) instead of using the complicated TXRF technique (Ref: M. Akhlak et al., J. Anal. At. Spect., Vol. 37, p 575 (2022)).

In the area of biological applications, some results include: crystal structure analysis of phycoerythrin from marine cyanobacterium Halomicronema to understand the light harvesting mechanisms in this system (Ref: S. N. Patel et al., J. Biomol. Str. Dyn., <https://doi.org/10.1080/07391102.2022.2055647>). The structural aspect of HomA and HomB proteins using various computational, biophysical and small-angle X-ray scattering (SAXS) techniques have been explored to understand their role in gastric malignancies (Ref: A. Tamrakar et al., Sci. Reps., Vol. 11, p 24471 (2021)).

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