Completed projects:

1. Title: Probing Magnetic Structures and Spin Flop transition in bulk and nanostrutured FeVo4 Multoferroic System

Funding Agency: DAE-UGC

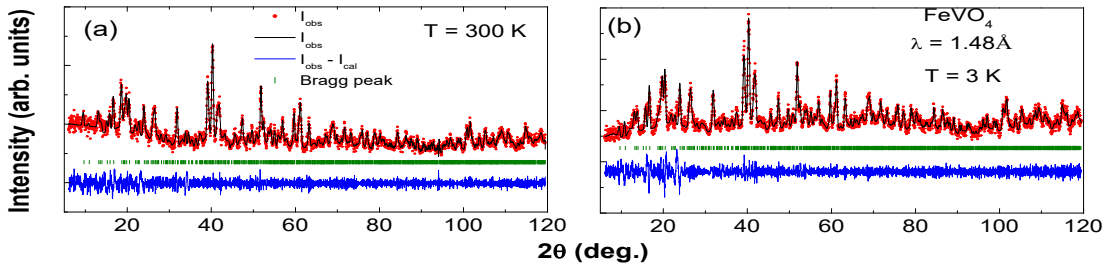
Completion date: December 2019

Project PI: Ambesh Dixit

Project Co-PI: NA

Brief description: The coexistence of magnetic and ferroeoelctric ordering in a single phase material is difficult and only few materials exhibit such characteristics, known a smultiferroics. FeVO4 is one such material with additional interesting features. The project aimed to investigate the microscopic origin of magnetic field induced spin flop transition in FeVO4 together with detailed magnetic structre.

Schematics or Pictures:



Neutron diffraction measurements (a) 300 K and 3 K on bulk $FeVO_4$ powder sample

Outcome: Highly anisotropic nature of FeVO4 is demonstrated with large variation in different lattice parameters with temperature.

Publication if any:

1. A Tiwari, S Kumawat, S Rayaprol, A Dixit, Neutron diffraction studies on temperature driven crystallographic anisotropy in FeVO4 multiferroic: Evidence of strong magnetostructural correlations, AIP Conference Proceedings 2115 (1), 030526 (2019)

2. Title: Design and development of high capacity and low cost Li2TMSiO4 (TM=Transition Metal) silicate materials for future rechargeable lithium ion battery technologies

Funding Agency: DST

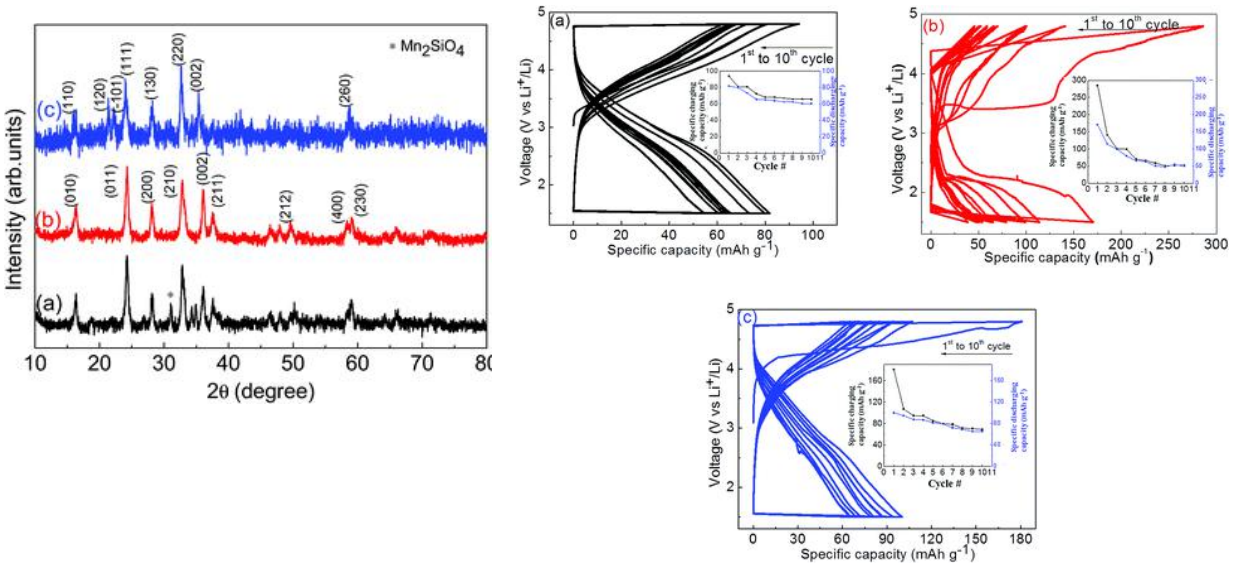
Completion date: 2017

Project PI: Ambesh Dixit

Project Co-PI: NA

Brief description: High energy density lithium ion battery materials are critical for power applications. This project aimed to design and develop high capacity and energy density silicate cathode materials for lithium ion batteries.

Schematics or Pictures:



XRD patterns and respective charge/discharge capacity of LMSO system

Outcome: Mateials with high energy density and capacity are designed and investigated. Further, the structure-property correlations are investigated to achieve high energy density in such materials.

Publication if any:

1. I. A. Ivanischeva, A. V. Ivanishchev, A. Dixit, Positive effect of surface modification with titanium carbosilicide on performance of lithium-transition metal phosphate cathode materials, Monatsh Chem (2018).

2. P. Babbar, A. Invanischev, A. Churikov, A. Dixit, Electrochemical behavior of carbonic precursor with Na3V2(PO4)3 nanostructured material in hybrid battery system, Ionics 23 (11), 3067-3071, (2017)

3. P. Babbar, B. Tripathi, B. Purohit, A. Ivanishchev, A. Churikov, A. Dixit, Charge/discharge characteristics of Jahn-Teller distorted nanostructured orthorhombic and monoclinic Li2MnSiO4 cathode material , RSC Advances 2017

3. **Title:** Development of plasmonic metal hybrid electrode system for II-VI quantum dot sensitized solar cells (QDSSCs): Realization of carrier multiplication for better efficiency

Funding Agency: DST

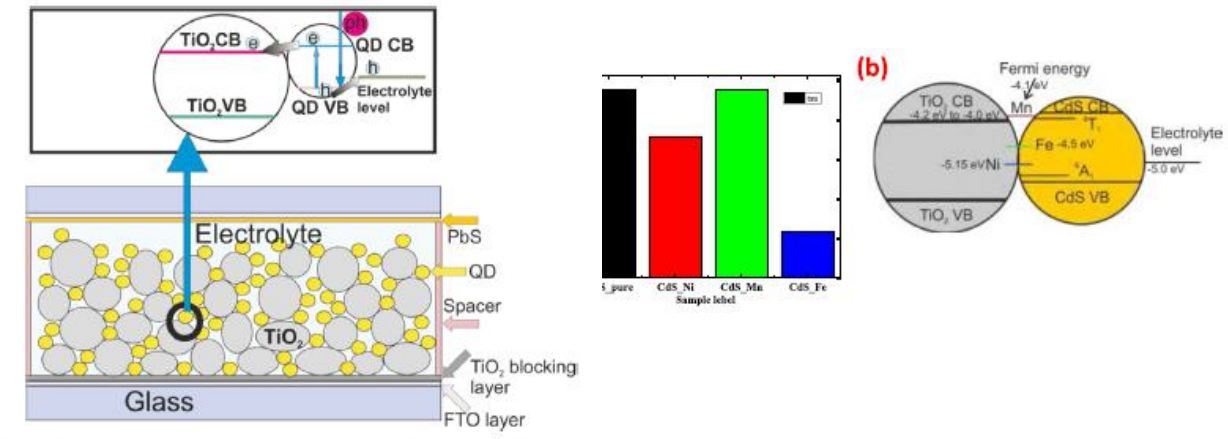
Completion date: December 2016

Project PI: Ambesh Dixit

Project Co-PI: Kiran K Hiremath

Brief description: QDSSCs are considered as next generation solar cells, showing possibility of beating S-Q limit by utilizing carrier multiplication. The project aimed to develop such QDs where carrier multiplicaiton can be realized as a bulk phenomenon.

Schematics or Pictures:



QDSSC structure with respective band diagram (left panel), and TM doping strategies in QDs for efficient PV response.

Outcome: A new method of integrating QDs in porous large band gap semiconductor is investigated and showed the best PV efficiencies reported so far on such QDs. Further, design criteria of doped QDs is proposed with microscopic mechanism to realize the improved efficiencies.

Publication if any:

1. A Sahu, A Garg, A Dixit, A review on quantum dot sensitized solar cells: Past, present and future towards carrier multiplication with a possibility for higher efficiency, Solar Energy 203, 210-239 (2020)

2. A Sahu, K Hiremath, A Dixit, Limiting efficiency factors and their consequences on quantum dot sensitized solar cells: A detailed balance study, Applied Physics A, 124, 541, (2018), I.F. 1.694

3. A Sahu, A Dixit, Design criteria of transition metal dopants in TiO2/CdS photoelectrode for enhanced photovoltaic response, J Phys Chem Solids, (2018),I. F. 2.048 https://doi.org/10.1016/j.jpcs.2018.06.021
4. A Sahu, S Tirosh, KR Hiremath, A Zaban, A Dixit, A novel process for sensitization and infiltration of quantum dots in mesoporous metal oxide matrix for efficient solar photovoltaics response, Solar Energy 169, 488-497 (2018); I.F. 4.374
5. A Sahu, R Chaurashiya, K Hiremath, A Dixit, Nanostructured zinc titanate wide band gap semiconductor as a photoelectrode material for quantum dot sensitized solar cells, Solar Energy 163, 338-346 (2018), I.F. 4.374

4. **Title:** Investigation of magnetoelectric coupling in Cu1-xTMxO multiferroic system

Funding Agency: BRNS-DAE

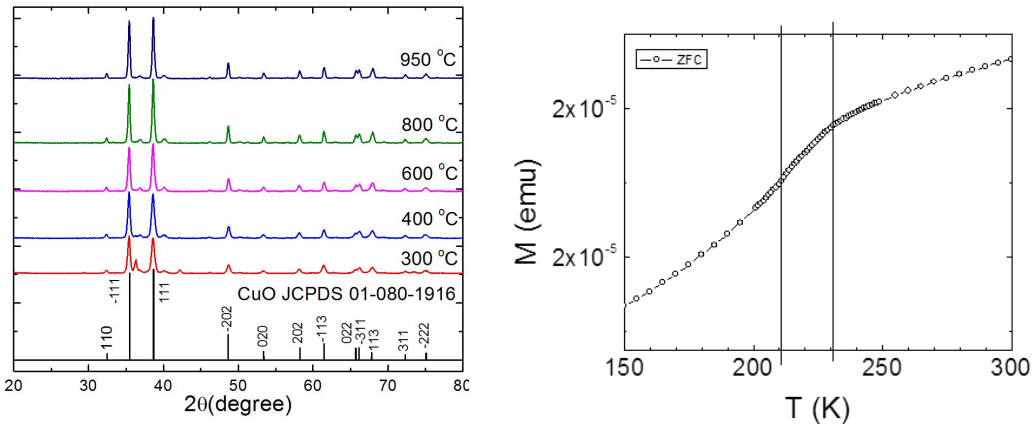
Completion date: December 2017

Project PI: Ambesh Dixit

Project Co-PI: NA

Brief description: CuO is a p-type semiconductor together with interesting ferroic properties, showing non-collinear AFM and ferroelectricity between 230 – 210 K. The objective of the project was to understand the robustness of the multiferroic transition against transition metal doping and any change with internal chemical pressure.

Schematics or Pictures:



XRD patterns of CuO nanoparticles and representative ZFC curve shoing the respective AFM transitions.

Outcome: AFM structures are investigated using magnetic and temperature dependent neutron diffraction. The impact of doping on CuO is not showing much change in AFM characteristics, suggesting that probably sufficient internal chemical pressure is not induced on doping to see any significant changes.

5. **Title:** Development of high thermal conductivity PCM composite for thermal management

Funding Agency: CHESS-DRDO

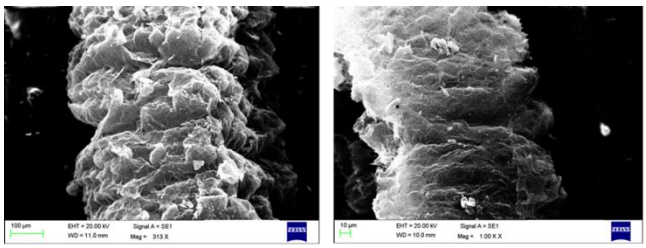
Completion date: 2016

Project PI: Ambesh Dixit

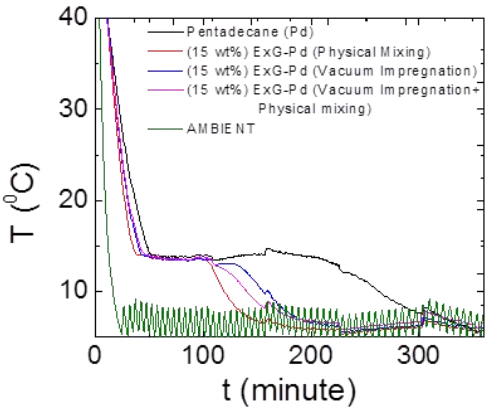
Project Co-PI: NA

Brief description: The project aimed to expolre suitable PCMs for thermal management of some strategic applications and modulation of their thermal conductivity for efficient heat transfer.

Schematics or Pictures:



Exfoliated graphite (ExG) 5% (wt) ExG - pentadecane composite

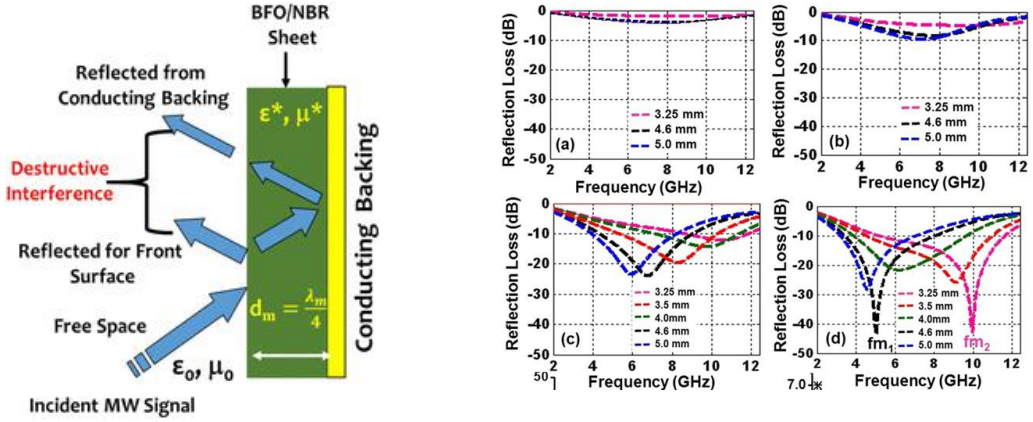


Exfoliated graphite as a host matrix(left panel, left figure), with PCM (left panel right figure) and T-history meausrement data on developed composites.

Outcome: We developed hybrid composite PCM with high latent heat and thermal conductivity, suitable for thermal management. The thermal conductivity can be enhanced by one order of magnitude by using optimized porous network of developed high thermal conductivity matrix, which further assisted in achieving the shape stablization of the composite PCM.

6. **Title**: Development of ferroelectric material and their composites with hexaferrites for microwave absorption applications; DLJ-DRDO: 2012 – 2014
Funding Agency: DLJ-DRDO
Completion date: 2014
Project PI: Ambesh Dixit
Project Co-PI: NA

Brief description: The project was targeting to design and develop materials of strategic importance for stealth applications in microwave region of EM spectrum.
Schematics or Pictures:



Attenuation mechanism in BFO/NBR composite in the microwave range (left panel) and reflection Loss (R.L.) over frequency range 2–12.4 GHz and matching thicknesses of different ferrite loaded rubber composites (right panel),

Outcome: We developed new functional materials, which can be used for broad frequency range and the work led to one patent. Further, the work led to the understanding of microwave absoroption in ferroelectric mateials and proposed a concept of dual band absorption for the first time in ferroelectrics.

Publication if any:
1. L. Saini, S. K. Barala, M. K. Patra, R. K. Jani, A. Dixit, S. R. Vaderaa, Ferroelectrically Induced Dual Band Microwave Absorption in Multiferroic BiFeO3/Acrylo-Nitrile Butadiene Rubber Composites, Applied Physics A 123 (11), 685 (2017)
2. L. Saini, M. K. Patra, R. K. Jani, G. K. Gupta, A. Dixit, S. R. Vadera, Tunable twin matching frequency (fm1/fm2) behavior of Ni1-xZnxFe2O4/NBR composites over broad Microwave frequency range (2-12.4GHz), Scientific Reports Nature, 7, 44457 (2017)

3. L. Saini, Y. Janu, M. K. Patra, R. K. Jani, G. K. Gupta, A. Dixit, S. R. Vadera, Dual band resonance in tetragonal BaTiO3/NBR composites for microwave absorption applications; J. Am. Cerm. Soc., 99, 3002 – 3007 (2016)

7. Title: Development of III-Nitride thin film(s) for high frequency SAW device applications

Funding Agency: ISRO

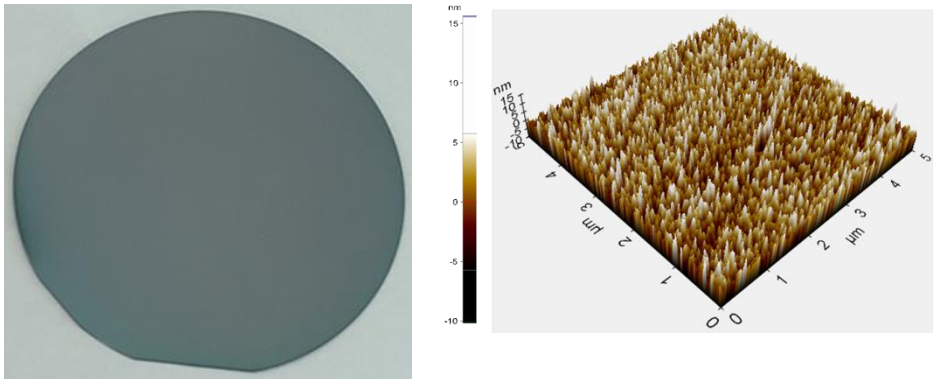
Completion date: 2019

Project PI: Ambesh Dixit

Project Co-PI: NA

Brief description: The project targeted to develop hybrid ALD-Sputtered AlN thin films for SAW device applications.

Schematics or Pictures:



AlN/AlN(ALD)/Si(111) *AFM Surface topograph*

Optical photographs of 3"diameter AlN/AlN(ALD)/Si(111) thin film (left panel) and AFM micrograph (right panel)

Outcome: Large 3" diameter AlN sputtered thin films are grown using the hybrid approach with a AlN (50 nm) buffer layer.