

# My life journey as a materials scientist

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Everyone has a different life journey from others. In that journey itself, we generally experience either happy or sad moments. My journey is filled with a lot of eventful and unique moments. The following is the story about my life journey which begins until the day where I stand today. It includes my family backgrounds, my schooling, my graduation to Ph.D., my research career (Dr. KSKRA fellowship at BARC, Scientific Officer position at BARC), my significant contributions to the society, recognitions/awards, and my words.

## ***My family backgrounds:***

I was born of a poor and illiterate family of (Late) Ningthoujam Kula Singh and (Late) Ningthoujam Ongbi Akoijam Meipak Devi of Thoubal Achouba, Makha Leikai, on 16<sup>th</sup> August, 1970 (Sunday). But my date of birth is found to be recorded as 1<sup>st</sup> February, 1972, (Fig. 1). I am the 10<sup>th</sup> and the youngest child in the family of ten children. Presently, only elder brother (N. Lalhari Singh) and elder sister (Lisam Ongbi Ningthoujam Sakhitombi Devi) are

alive. Some of our siblings had lost their lives before I was born, except one sister (Late) N. Shanti Devi and (Late) N. Memcha Devi.



**Fig. 1: My Parents**

Coming to my family life, I was married to Thounaojam Promila Devi, daughter of Late Thounaojam Modhu Singh and Thounaojam Ongbi Yumnam Ibemhal Devi, on 1<sup>st</sup> March 2002 (**Fig. 2**). My wife has 2 more younger sisters and one elder brother (Late Th. Dhiren Singh). We are now parents of one son and one daughter. The names of my son and daughter are Ningthoujam Sirdhartha (born on 09/12/2002) and Ningthoujam Manileima (born on 15/05/2004) respectively.

### ***My Schooling***

#### ***Nursery***

The most important memory of my early childhood is about my early schooling. I clearly remember my first day at school and the memories of this day are still vivid. I started my 1<sup>st</sup> pre-school study (known as Mapi) at Bamol school (Keina) located at Thoubal Achouba, Manipur. I used to go to school along with my elder sister (Late Ningthoujam Shanti Devi). Thereafter, I changed my school to Kanga Senbi School where I completed my class I and II.

It is worthwhile to mention that during those days, I used to carry Gunny Bag (Bora Khao) made of Jute fibers to sit on it during classes. At that time, there were no proper school and thus, classes were conducted in a thatch hut so called *Sangoi* (hut constructed in front of house). I still remember some of the teachers who took classes during those days, and they are Bamol Keina, Ningthoujam Muktarei Devi, R. K. Achousana, etc.



My family (2008):  
Left to Right- Myself (Raghumani Singh Ningthoujam), Son (Sirdhartha Ningthoujam), Daughter (Manileima Ningthoujam), Wife (Thounaojam Promila Devi) at Mumbai



1986: My participation in NCC (National Cadet Corps) during schooling at Chaoyaima Hr. Sec. School, Thoubal, Manipur

**Fig. 2 (Left) My family and (Right) My active participation in NCC during schooling**

### ***Primary***

After class II, I shifted my schooling to a Primary Boys School, located at Thoubal Nongangkhong, Manipur and studied there from classes III to V. I grew up as an average student, many a time, I stood up on the bench as a punishment of the teacher for failing to give answer of his/her question /assignments. Consequently, at home, I was taken care of by a private teacher called R. K. Muktasana (Late). My school life is a wonderful chapter in my memories because I learned dedication, hard work and motivation. After coming back from school, I used to go to the paddy field (Thoubal Loukol) and the adjoining lake, so called Thoubal Pat, to bring back the cattle which were set free to graze. In fact, it was very tiresome

task for me as I had to locate the whereabouts of cattle, sometimes; it took three hours to find the cattle. Because of all these activities, I used to ignore my study. A few teachers of the school who took care of me as I still remember, include A. K. Angoubi (Cousin sister), Longjam Modhu Singh (Head Master, now no more).

### ***Secondary***

My time in high school was an equally valuable learning experience. I studied from class VI to X at Chaoyaima Higher Secondary School, Thoubal, Manipur. As I belonged to an illiterate family and also I was not much aware of education, most of the time I was assigned to one or the other activities such as paddy cultivations, cropping, nurturing of plants, taking care of cows etc. As a result, I remained as an average student in the school. I was one of the active cadets of our school NCC (Fig. 2). As far as my academic career is concerned during schooling, I was never a topper from primary school (III) to Class X. However, I used to work hard towards my goals. Some of the teachers who taught us various subjects in the school were Oja Kumar (Mathematics), Oja Bedabati (Mathematics), Oja Kulla (drawing), Oja Sanahalbi (English), Oja Amu (English), Oja Ibohal (Physics), Oja Subash (Higher Mathematics), Oja Sanahalbi (Manipuri), Oja Kunjo (Hindi), Oja Lalji (Geography), Oja Manileima (Manipuri), Oja Mohindro (Chemistry) etc. In 1987, I appeared in class X examination which was conducted by the Board of Secondary School, and I passed in the Third Division.

### ***Intermediate***

After class X examination, I was compelled to change my school from Chaoyaima Hr. Sec. School to Thoubal College for Pre-University Course (class XI - XII) in Science, due to poor performance in the Class X examination. Some of the teachers of the college, were Dr. R. K. Yaikul Singh, O. Chaoba Singh, Lukhol, Ahmad, etc. In 1989, I appeared in P.U.Sc. (XII) examination, conducted by Manipur University and I passed it with second division. I was always self-motivated and I never lose hope. I always prayed to God to have good health and good thought to become good student since then.

### ***College***

After passing P.U.Sc. examination, I started thinking of good score in B.Sc. examination. Therefore, I tried to get admission, first at DM College (now D. M. University) and later on at Imphal College, which are premier colleges of the State. Since I could not score good marks in the main subjects in P.U.Sc. examination, my efforts to get admission in these best colleges of

Manipur were futile. Later on, I tried at Modern College, Porompat, Imphal, Manipur and got admission in B. Sc.1<sup>st</sup> year and completed BSc 2<sup>nd</sup> year there. Some of my teachers were Dr. Kh. Ajit Singh, Th. Bormani Devi, Dr. O. Ibopishak Singh, N. Indubala Devi, Dr. Asem Bimola Devi, Dr. Th. Nandababu Singh, Dr. Kh. Manihar Singh, M. Brajeswori Devi, Dr. L. Pishak Devi, Dr. Sinha. Although, I was admitted in the Modern college, Imphal but my thrust to get admission in either at Imphal College or D. M. college was not over. Once again, I applied for admission at Imphal College for study in 3<sup>rd</sup> year which was the last year of B.Sc. degree course (or TDC, Third Year Degree Courses) and also the time of choosing Honours subject. This time, I got admission at Imphal College in Chemistry Honours. This was my turning point of my academic career; I was the highest mark scorer in chemistry honours, dominating the other students previously studying there. In the meantime, in the same year, I lost my beloved father. I was supposed to pass my TDC course in 1992, but due to the delay in result declaration, the degree was obtained in 1993. I passed TDC in the second division with 2 marks lesser than the 1<sup>st</sup> Division. In that examination, I got more marks in theory section than that of experimental section. Though illiterate, my parents took care of my study a lot. Being a poor family, my parents were very hard to afford my monthly expenditures. As a result, every Saturday evening, I went down to home and back to Imphal (rented house) on the next day (on Sunday) along with a few kgs of rice, green vegetables cultivated at home, and a small amount of money which would last for a week. Even, my brother-in-law (Lisam Ibochouba Singh) helped me during my stay at Imphal. It still strikes the mind, “How hard one struggle in my village to earn money” at that time. From that time onwards, I used to spend time judiciously and avoided bad habits which could ruin my life.

### ***Master***

Before applying for admission in M.Sc., I applied for getting a job in Army (Assistant Commandant post in SSB, Border Security Force), but I did not appear the examination. For me, there was no chance to study outside Manipur as my mother did not have enough money for this expenditure. For getting admission into M.Sc. course in chemistry in Manipur University, I faced an entrance examination. In that entrance examination, I topped and thus I was admitted into M.Sc course in chemistry in the Manipur University. Thank you almighty for blessing. I was always self-motivated since then. In 1994, I passed M.Sc. in First Class with 2<sup>nd</sup> position (provisionally), but formally, the result was declared in 1996. At that time the Manipur Association for Promotion of Science (MAPS) was in full swing. I was actively involved for organization and distribution of its bulletins. I came across many teachers - Prof.

N. Rajmuhon Singh, Prof. N. Nimai Singh (Faculty at Physics Department, Gauhati University and now at Manipur University), Prof. N. Sanajaoba (Faculty at Law Department, Gauhati University and now no more), Prof. N. Debananda (Faculty at Biochemistry Department, Manipur University), Prof. L. Warjeet Singh (Faculty at Chemistry Department, Manipur University), Prof. R. K. Bhubon Singh (Faculty at Chemistry Department, Birmangol College, but now in Chemistry Department, Manipur University). They motivated and advised me a lot to do my research works at reputed and premier Universities/Institutions.

***Intermediate period (after M. Sc. and before joining Ph. D.)***

In the meantime, I faced an interview for lecturer post and got selected and served for some time as a lecturer in the Chemistry Department, Waikhom Mani Girls' College, Thoubal, Manipur in 1996. Some of my colleagues of the department were N. Sobhakaran Singh, Adjad Sekher, Dr. Atom Rameshor Singh, L. Sanatombi Devi. Besides, I was appointed as Project Assistant in Chemistry Department, Manipur University under Prof. L. Warjeet Singh for the period of one year. In 1997, I applied for a Part-time lecturer post of Govt. Schools and got selected and served as a part-time lecturer for some period of time at C. C. Hr. Sec. School, Imphal. In the month of December of the year, I got selected for Ph. D. program in Chemistry at IIT Kanpur, India.

***Ph. D.***

At the same time in the same year (1997), I also tried to join Ph.D. Program of Chemistry Department at IIT Delhi during June session. For which I missed the interview as the call letter came late. Thereafter, I discussed with Prof. S. K. Srivastava of Manipur University for Ph. D. Programme in 1997 (December session) of Chemistry at IIT Kanpur and applied for it. A few persons who helped me arranging telephonic call to IIT Delhi and IIT Kanpur were Late Soibam Momon Singh (neighboring elder brother as telephone operator) and Dinesh Singh (JTO, Imphal microwave station). When I remember, I received a telegram letter from the Head of Chemistry Department, IIT Kanpur, Professor S. K. Dogra, in the last week of November 1997 for the Ph. D. programme. It was only 5 days' time for the interview. On the very next day, I went to Imphal along with an intimate friend of mine, Soibam Arunkumar Singh of my locality. I took some financial helps from cousin brothers, late Ningthoujam Mohindro Singh and late Ningthoujam Nabachandra Singh for visit to Kanpur. My worry was that if I had gone by bus from Imphal to Guwahati to minimize my expenditure, I would most likely to miss the interview. Moreover, no bus was plying on the national highways due to an ongoing strike. So,

my only option to reach Kanpur in time was by air from Imphal to Calcutta and then from there to Kanpur by train. Consequently, I booked the flight ticket for Imphal to Calcutta. From Calcutta, somehow, without having any experience of train journey, I reached at Kanpur. That train journey was very memorable and miserable also. When I reached at Calcutta, I went directly to Howrah railway station without booking ticket to catch train for Kanpur. One security personal asked me to book a ticket and thus I booked a ticket for general compartment. By getting a ticket, I went directly to general compartment which was meant for sitting only. The moment was very tough for me as I was lacking the communication skill in Hindi. On the other hand, those fellow passengers sitting nearby were all Hindi speaking people. As I did not know the time to reach the Kanpur railway station, many times I asked about Kanpur railway whenever any station came. After reaching the Kanpur railway station, I hired an auto-rickshaw to reach IIT Kanpur. When I reached IIT Kanpur, I met one Manipuri senior friend (Okram Barun Singh), who was undergoing Ph. D. programme in the same institution under Prof. H. Ila. The Professor H. Ila was earlier serving as a faculty member at Chemistry Department, NEHU, Shillong. Later on, she shifted her service to the IIT Kanpur in 1995 (probably). I was having keen interest in doing my Ph. D. programme in Solid State Chemistry. In the form submission of the programme, 1<sup>st</sup> option was solid state chemistry, out of the four options provided. In order to meet my expenditures for admission, travelling and others, a portion of our cultivation land was mortgaged for some years. By virtue of God's blessing, I got selected for the Ph.D. programme in Chemistry at IIT Kanpur under the guidance of Prof. N. S. Gajbhiye (Solid State Chemist). After the confirmation of my selection for the said programme, I came back to Manipur for some time. After some days in Manipur, I went back to IIT Kanpur for my admission and the admission procedure was completed during the last week of December, 1997 (Fig. 3). I registered my Ph.D. works under the topic "Synthesis, characterization of transition metal nitrides and superconductivity and magnetic properties". I could publish my first research paper in the year 2002 that was after 4 years of my research work. Thereafter, I submitted my Ph. D. Thesis on 27<sup>th</sup> September 2004. During those days, I used to read Employment News, published weekly. One day, I came across an advertisement about the Dr. KSKRA fellowship in one of Employment News. The last date for application for that fellowship was probably in the month of September 2004. I was just on the following day of my Ph.D Thesis submission. In no time, I applied for the fellowship and I was called for the interview during the first week of January 2005.



December 2001: My poster presentation at IIT Kanpur: Solid State Chemistry and Allied Areas



2003: Mossbauer room at IIT Kanpur



31/05/2005: Attending convocation at IIT Kanpur



31/05/2005: Received PhD degree from Director, IIT Kanpur

**Fig. 3 During Ph.D. period: December 1997 to May 2005**

***Research associate (RA)***

I went to BARC to face the Interview for the Dr. KSKRA fellowship in the first week of January 2005. When the interview was just completed, on the day itself, one of the board members of the interview informed me to do Medical Check-up on the next day. The moment I heard the words from the board member, I could realize that I was selected for the fellowship applied for. I was insisted by some of the scientists working in VCC, Kolkata to join in the Kolkata unit. On the following day, I went for Medical Check-up to Anushaktinakar, BARC/ DAE Colony



along with a friend of mine, Dr. Sudhir Gupta, who was already selected as KSKRA fellow in Biological group. From the day onwards, we have been in good relation and sharing all sorts of matters including family matters and others, till today. When medical checkup was over, I went to IIT Kanpur to meet my Ph. D. Guide, he advised me to join the BARC, Mumbai. Just after a few days of my Ph. D. defense was over, on 25<sup>th</sup> February 2005, I joined the Chemistry Division, BARC, Mumbai as Dr. KSKRA position. I submitted my joining report to Dr. S. K. Kulshreshtra, Head of Chemistry Division. In 2006, NSC and AC divisions of BARC were merged to form Chemistry Division of BARC. In 2005, at the time of joining in the BARC, I was in the NSC division there I was working as Dr. KSKRA fellow up to 31/07/2024. During my Dr. KSKRA fellowship, I had been working in the area of Optical properties of semiconducting nanomaterials including quantum dots (QDs). Some of semiconductors could not generate QDs due to small sized exciton Bohr's radius. Examples are SnO<sub>2</sub>, TiO<sub>2</sub>, Y<sub>2</sub>O<sub>3</sub>, etc. When one system is dispersed to another, it can generate exciton or QDs. This work was initiated in 2005 during my KSKRA period. Lanthanide ions doped semiconductors were prepared using ethylene glycol solvent and studied their optical property.

#### ***Absorption in chemistry division, BARC, Mumbai***

On the 1<sup>st</sup> October, 2006, I joined the BARC, Mumbai as a Scientific Officer (D) in the Chemistry Division. At present, I am serving as a Scientific Officer (G). During this period, many systems including magnetic and luminescent nanoparticles including QDs were reported as my research findings. The applications of QDs in biological area, anticounterfeit and sensors have been reported. I joined the Post-Doctoral fellowship at Chemistry Department, University of Victoria, Canada under Prof. Frank van Veggel in the area of QDs.

#### ***Supporting to students or collaborative works***

During the period of 2006-2024, I have supported many students in the field of various research works. Many of my students occupied various respectable faculty positions in various Universities of India and abroad. With some of them, I am still keeping in touch by doing some collaborative works. Apart from my area of research, I used to encourage and provide various supports belonging to various branches of science. Altogether, about 100 students including, Internship, Summer Academic Fellows, Training across India have been provided with various supports.

#### ***Publications and citation index***

So far, about 170 research articles, 6 review articles, 20 book chapters, and 5 books (edited) were published. Some of the published journals can be mentioned: Appl. Phys. Lett., J. Appl. Phys., Phys. Rev. Mater., J. Am. Chem. Soc., Chem. Phys. Lett., J. Mater. Chem., Dalton Transactions, ACS Appl. Interface, ACS Appl. Nano Materials., J. Phys. Chem, ACS Photonics, Inorganic Chemistry, Nanotechnology, RSC Adv., Indian J. Phys., Pramana, Progress in Mater. Sci., etc. Till date (April 14, 2024), citation index in my publication is H-61 (Google Scholar) with total citation 10100 or H-54 (Scopus) with total citation 8050.

### ***Significant works in research areas***

My contributions to Science and Technology are briefly mentioned here:

#### ***(A) Rare-earth doped nanomaterials***

##### ***(i) Finding of freezing temperature of confined water at -50 °C in orthophosphate***

For the first time, my group is able to distinguish the free water on the surface of particles and confined water in the pores or interstitial water in the hexagonal structure of orthophosphate using NMR technique. Luminescence quenching in hexagonal REPO<sub>4</sub> phase is due to content of confined water, which is near to metal ion (Y<sup>3+</sup>/Bi<sup>3+</sup>/Eu<sup>3+</sup>) and far from PO<sub>4</sub> group. This confined water is not frozen even at -50 °C due to less number of H-bonding.

##### ***(ii) Finding of water stability up to 800 °C in orthophosphate***

For the first time, my group is able to prove the stability of water up to 800 °C in case of hexagonal phase of YPO<sub>4</sub>:Eu co-doped with Ce, Bi by combined spectroscopy techniques including luminescence technique. This finding will give an alternative evidence for possibility of water present in rocks available in many planets, where temperature level goes up to 800 °C.

##### ***(iii) Finding of order positions of water molecules in orthophosphate***

For the first time, my group is able to find out order positions of water molecules in orthophosphate using neutron diffraction. Here, H<sub>2</sub>O molecules are replaced by D<sub>2</sub>O molecules. Otherwise, signal to noise is very low.

##### ***(iv) Luminescence on-off through redox reactions***

My group is able to perform luminescence on-off performed on GdPO<sub>4</sub>:Tb co-doped Ce<sup>3+</sup> using KMnO<sub>4</sub> as oxidizing agent and ascorbic acid as reducing reagent.

##### ***(v) Blue and white light emitters***

By combining different Ln<sup>3+</sup> ions, my group is able to tune colours including white emissions. E. g. Gd/Y/LaVO<sub>4</sub>, CaMoO<sub>4</sub>, Gd<sub>2</sub>O<sub>3</sub>, GdPO<sub>4</sub>, YPO<sub>4</sub>:Ln<sup>3+</sup>, CaF<sub>2</sub>:Ln<sup>3+</sup> (Ln<sup>3+</sup> = Dy<sup>3+</sup>, Eu<sup>3+</sup>, Sm<sup>3+</sup>,

Tm<sup>3+</sup>). The quantum yields are found to be in range of 5-20%. The CIE colour coordinates of white emission is  $x = 0.35$ ,  $y = 0.35$ . Li<sup>+</sup> co-doping improves luminescence intensity.

***(vi) Rare-earth ions as probe in core-shell formation***

Using rare-earth ions as probe, my group is able to prove core-shell formation in nanoparticles in SnO<sub>2</sub>@SiO<sub>2</sub>:Eu, SnO<sub>2</sub>:Eu@TiO<sub>2</sub> and Y<sub>2</sub>O<sub>3</sub>:Ln@Y<sub>2</sub>O<sub>3</sub>, SnO<sub>2</sub>-Eu@Y<sub>2</sub>O<sub>3</sub>. Generation

***(vii) Generation of exciton between 2 semiconducting interface***

Some of semiconductors have small Bohr's radius (2-3 nm) and therefore, these could not produce quantum confinement property if size of particles has more than Bohr's radius. However, my group has generated QDs or quantum confinement effects on such semiconducting nanoparticles upon interaction with another semiconducting or insulating material. Some of examples are SnO<sub>2</sub>@SiO<sub>2</sub>:Eu, SnO<sub>2</sub>:Eu@TiO<sub>2</sub> and Y<sub>2</sub>O<sub>3</sub>:Ln@Y<sub>2</sub>O<sub>3</sub>, SnO<sub>2</sub>-Eu@Y<sub>2</sub>O<sub>3</sub>.

***(viii) NIR light harvesting***

My group prepared QDs of PbSe and studied NIR light harvesting using PbSe. The quantum yield is found to be 80%.

***(ix) Anti-counterfeited inks***

My group developed anti-counterfeit inks using luminescence materials such as YVO<sub>4</sub>:Ho-Yb and NaErF<sub>4</sub>: 0.5% Tm@ NaYF<sub>4</sub>: 20% Yb.

***(x) Super bright red emitter from Er<sup>3+</sup>***

Generally, Er<sup>3+</sup> ion in host shows the green and red emitter. Through trapping centre such as Tm<sup>3+</sup>, my group developed super bright red emitter in a particular host: NaErF<sub>4</sub>: 0.5% Tm@ NaYF<sub>4</sub>: 20% Yb nanoparticles for the first time.

***(xi) Bio-labelling***

My group developed biocompatible and highly stable luminescent up conversion nanomaterials such as NaErF<sub>4</sub>: 0.5% Tm@ NaYF<sub>4</sub>: 20% Yb and YVO<sub>4</sub>:Eu and have been used as marker in biology.

***(B) Nanomaterials for cancer therapy***

***i) Fe<sub>3</sub>O<sub>4</sub> based therapy***

My group has also carried out the magneto hyperthermia for the targeted and controlled drug delivery in cancer therapy. To carry drug (DOX) and magnetic nanoparticles (MNPs) to the

targeted site, temperature sensitive liposome is used. Induction heater is used to produce magnetic field as well as A. C. frequency. Enhanced drug release at 42-45 °C is found and this is required for killing of cancer cells. Fe<sub>3</sub>O<sub>4</sub> MNPs coated with polyethylene glycol (PEG) and Oleic acid are tested in a human breast cancer cell line (MCF7). Killing of cancer cells is found up to 70% within 10 minutes. Bi-functional properties of MNPs-Luminescence (Fe<sub>3</sub>O<sub>4</sub>-YPO<sub>4</sub>:Eu, Fe<sub>3</sub>O<sub>4</sub>-YVO<sub>4</sub>:Eu) having very high specific absorption rate (SAR = 100%) and red emitter at 615nm and 695 nm, which is in range of biological window are tested in mouse fibrosarcoma (Wehi 164) tumor cells by Prussian blue staining. The intra-cellular uptake of MNPS is observed. In order to perform site selective of cancel cells (including meta-stability), some new approaches: Antigen and Antibody combination process (since cancel cells lacks some specific amino-acids (e.g. folic acid)) and radio-isotope tracing (this can produce β-/ γ-ray in target sites) are under progress. Now, in vivo study in mice shows significant decrease of tumour size within 8 days in the presence AC magnetic field. Preclinical trial has been done. Outcome of this work will be applied to the clinical trial. There is collaboration between Scientists from BARC and Doctors from ACTREC, Mumbai. Also, engineer will be involved in designing Hyperthermia instrument for human patients. Also, combination of early diagnosis, chemotherapy, radiation and hyperthermia therapy are undergoing. This will reduce cost of treatment at affordable ways. To improve heating efficacy, the core@shell Fe<sub>3</sub>O<sub>4</sub>@A<sub>x</sub>O<sub>y</sub> (A = d and f block elements) are prepared and this will be the first time work in such work.

#### ***ii) Au based therapy***

My group developed the loading of Drug in to hollow Au/Ag Nanoparticles and this is useful in treatment of cancer (particularly brain tumor) under Visible or NIR light through photo thermal heating.

#### ***iii) Hybrid materials for photothermal heating or AC field heating as well as luminescence***

My group developed Hybrid nanomaterials (Au/Ag: NaYF<sub>4</sub>:Yb, Er/Tm/Eu; Fe<sub>3</sub>O<sub>4</sub>: NaYF<sub>4</sub>:Yb, Er/Tm/Eu; Fe<sub>3</sub>O<sub>4</sub>: YVO<sub>4</sub>:Yb, Ho) having multifunctional properties such as photothermal heating or AC field heating as well as luminescence. Also, hybrid of YPO<sub>4</sub>:Eu<sup>3+</sup>/K<sup>+</sup>-Fe<sub>3</sub>O<sub>4</sub> show the heating behaviour as well as luminescence.

#### ***iv) Mesoporous upconversion nanoparticles as a potent theranostic probe***

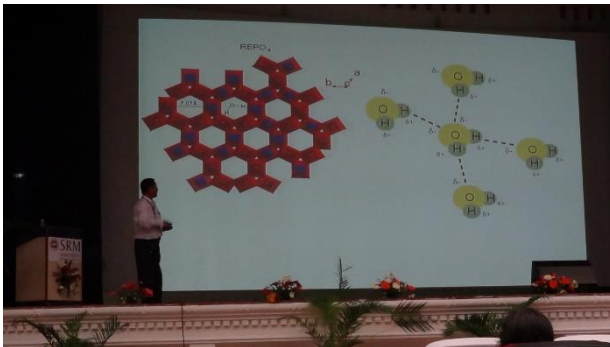
My group have developed mesoporous NaGdF<sub>4</sub>/Ho-Yb@m-SiO<sub>2</sub> upconversion nanoparticles which have multifunctional properties such as emission in visible and NIR region, higher drug loading and loading of radio-active ions such as <sup>177</sup>Lu for diagnosis and therapy of cancer.



January 2002: My first oral presentation at BARC, Mumbai (Multi-purpose Hall): Thermal Conference.



January 2013: Attending a conference at BHU, Uttar Pradesh



December 2011: Attending Solid State Physics Symposium at SRM University, Tamilnadu

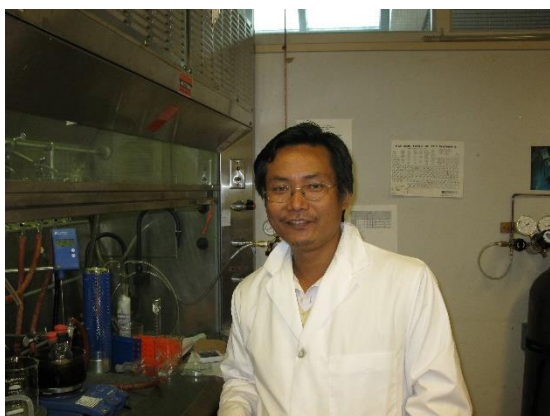


January 2013: Felicitation of my Ph. D. Guide Prof. N. S. Gajbhiye at his 60<sup>th</sup> birthday at NIT Nagpur. Release of a book compiled from his research papers by myself (R. S. Ningthoujam), Prof. S. J. Sharma, Prof. S. S. Umare at a conference

**Fig. 4 Attending conferences/workshops at various parts of India**

### *Conference talks*

I delivered more than 100 talks in conferences/seminars/workshops at different Universities/Colleges/Institutions (Figs.4,5). I attended first a conference at Manipur University (Manipur Science Conference) in 1996. Second and third conferences that I attended were at IIT Kanpur and BARC, Mumbai, respectively.



2012: Preparation of Quantum Dots (QDs) at Chemistry Department, University of Victoria, Canada where I did one Year PDF under Prof. Frank Veggel.



21/03/2024: Keynote Lecture at Chemistry Department, Manipur University at Conference



15/03/2024: Interaction with teachers and students of College at Beed district, Maharashtra at a Conference



03/04/2024: Panel discussion with participants at a Conference on Rare Metals and Related Materials (RAREMET 2024) arranged at Moscow.

**Fig. 5: (Left of Top) Post-Doctoral work at Canada. Others are related to conferences.**

***Family at DAE/BARC colony***

We have 5 Meitei Families in DAE/BARC colony. Many students from Manipur used to visit our family. In one occasion, Dr. N. Shanta Singh, Dr. Meitram Niraj Luwang, L. Premananda

Singh and another friend visited my flat and took dinner with family members at Restaurant (Fig. 6)



2013: BARC families with students



03/04/2024: Russian Academician, N. P. SAZHIN's Medal is awarded to Dr. RAGHUMANI SINGH NINGTHOUJAM FOR PERSONAL CONTRIBUTION TO THE DEVELOPMENT OF SCIENCE IN THE FIELD OF MATERIAL SCIENCE RESEARCH by Director (A. I. Golinei), Chemical Technological Block of JSC Science & Innovations of the Main Organization JSC, Giredmet, Moscow (2024)



03/042024: Citation at Moscow Conference



03/042024: Medal at Moscow Conference "For Excellence"

**Fig. 6: (Left side of Top) BARC Families with students. Others are related to award given to me at Moscow on 03/04/2024.**

### ***Student interactions in colleges/Schools***

I used to go to colleges and schools of Manipur/Maharashtra/Bihar and interacted with students for their futures. Many lectures on importance of science (World Science Day, National Science Day) in development of society were delivered to students/teachers.

### ***Awards/Recognition***

I was recognized or awarded for my significant contributions in Materials Science (Interface between Chemistry, Physics and Biology). I learned many ideas and techniques from my students, who had done their research works or training with me. I thank you all, who were part of my research career. Without their contributions, it is not possible to achieve this.

- (1) Fellow, National Academy of Sciences, India (2016)
- (2) Fellow, Maharashtra Academy of Sciences (2013)
- (3) Scientific & Technical Excellence Award (2012), DAE, Govt. of India
- (4) Young Achiever Award (2011), 55<sup>th</sup> DAE Solid State Physics Symposium
- (5) Young Associateship, Maharashtra Academic of Sciences (2010)
- (6) Best Poster/Oral Prizes (5 numbers)
- (7) Inclusion of Name in Top 2% Indian Scientists in 2020, 2021, 2022, 2023
- (8) CRSI Bronze Medal for year 2022
- (9) MRSI Medal for year 2022
- (10) SMC Silver Medal for year 2023
- (11) N. P. SAZHIN's Medal (Russia) (Fig. 6)
- (12) Short listed in the Swarnajayanti Fellowship (2011)

### ***My final words***

Let us work hard sincerely, do our duty, and continue our works as possible as, support students, who need us for future, love our works, feel as workers, always trust works, never leave our tasks even if it fails, work with courage and curiosity, generate beautiful thoughts/idea. I used to give 12-14 hours for my research works per day during official working days.