NAAC RE-ACCREDITED WITH 'A' GRADE

Sevadal Mahila Mahavidyalaya

Place for Higher Learning and Research
(Research Academy)
Sakkardara Square, Umrer Road,
Nagpur - 440024 (India)

Advanced Materials Science Laboratory
Institute of P.G. Studies and Research
UNIVERSITY OF MALAYA
KUALA LUMPUR,
MALAYSIA

A MEMORANDUM OF UNDERSTANDING

Between

Advanced Materials Science Laboratory
Institute of P.G. Studies and Research
UNIVERSITY OF MALAYA
KUALA LUMPUR, MALAYSIA

And

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Sakkardara Square, Umrer Road,
Nagpur - 440024 (India)

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

Sevadal Mahila Mahavidyalaya

Sakkardara Square, Umrer Road, Nagpur

MOU, Collabration

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Prof. Pravin Charde
Principal
Sevadal Mahila Mahavidyalaya

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding is made and entered into this **12th** day of **February, 2020**:-

Between

UNIVERSITY OF MALAYA, a University established under the laws of Malaysia.
Advanced Material Science Laboratory, Institute of P.G. Studies and Research, University of Malaya, Malaysia (hereinafter referred to as "**(AMSL)**") having its registered address, Advanced Material Science Laboratory, Institute of P.G. Studies and Research, University of Malaysia, Malaysia.

And

Sevadal Mahila Mahavidyalaya, a college affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur (India) established under the laws of India. (hereinafter referred to as "**SMM**") having its registered address at Sakkaradara Square, Umrer Road, Nagpur of the other part.

AMSL and SMM shall be individually referred to as a "Party" and collectively as "Parties".

1. SCOPE AND FIELDS OF COOPERATIONS

(1) The Parties hereby agree to implement within the framework on the development **"Development of Rare Earth Activated Inorganic Phosphors and their Applications for Lamp Industry and Radiation Dosimetry"** with the rules and regulations applicable in each of the institutions and subject to availability of funds and resources, the following programs and activities, which may include, but not limited to;

(a) Interest of collaboration

The main objective of this work is to synthesize and characterize of down conversion phosphor and its use for increasing the efficiency of solar cell either by applying thin layer on the top of Si solar cell or by mixing developed down conversion phosphor in the precursor of silicon solar cell at the time of manufacturing.

(2) SMM, and AMSL, through the research and development activities of its Advanced Material Science Laboratory, Institute of P.G. Studies and Research, University of Malaya, Malaysia has special interest, knowledge and experience in the development of Power Electronics facilities and equipment that can be used to mutual benefit in the furtherance of the research aims of both organizations.

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

(3) It is agreed that the terms and conditions of any agreed program and activity contemplated in this MOU shall be the subject matter of separate written agreements to be negotiated and agreed upon by both Parties and/or any third parties, wherever applicable. Provided always the decision whether to initiate and/or implement any program or activity shall be at the sole discretion of each Party.

2. FINANCIAL ARRANGEMENTS

The Parties acknowledge that in the absence of any specific agreement in writing to the contrary, each Party will be responsible for its own costs and expenses in establishing and conducting programs and activities contemplated under this MOU, including without limitation its own costs and expenses in travel and accommodation.

3. JOINT PROPERTY

(1) The Parties agree that any intellectual property rights arising from or in connection with any program or activity under this MOU, through and by the joint and collaborative efforts of both Parties shall be jointly owned and subject to any other terms and conditions as may be agreed upon in writing.

(2) Both Parties shall acknowledge one another in any form of writing, publication or presentation based on research derived from the cooperative efforts of both Parties under this MOU, unless otherwise mutually agreed upon in writing by the Parties.

4. CONFIDENTIALITY

(1) During the term of this MoU, each Party shall treat all information disclosed to it by the other Party in connection with the collaboration as confidential ("Confidential Information") and shall employ same internal security procedures and with the same degree of care regarding its secrecy and confidentiality as the Party receiving the disclosure treats similar information of its own within its organization. Confidential Information does not include information that:

(i) is available to the public through no breach of this MoU;

(ii) is obtained from a third party with the legal right to disclose the information; or

(iii) is required to be disclosed by law, government regulation, or court order.

(2) The Parties agree and undertake to keep confidential at all times any information or data that may be exchanged, acquired or shared in connection with any program or activity conducted pursuant to this MOU save where the same is already in public domain.

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

5. DURATION AND TERMINATION

(1) This MOU shall take effect on and from the date of execution of this MOU and shall continue to be effective for a period of three (3) years and may be extended for such further period as may be agreed by the Parties in writing.

(2) Notwithstanding clause 5 (1) above, this MOU may be terminated by either Party giving written notice to the other at least six (6) months prior to the proposed date of termination.

(3) Notwithstanding clause 5 (2) above, the provisions of this MOU or any other written agreement in respect of any on-going exchange program or any other form of cooperative activity under this MOU shall continue to apply until their completion unless both Parties mutually agree in writing to the earlier termination of the program or cooperative activity.

6. NOTICE

(1) Every notice, request or any other communication required or permitted to be given pursuant to this MOU shall be in writing, in English and delivered personally or sent by registered or certified post via air mail or by courier or facsimile (which shall be acknowledged by the other Party) to the Parties at the address and facsimile number as stated below:

(a) **If to AMSL : Dr. B. Vengadaesvaran**
Research Director, Advanced Materials Science Laboratory
Institute of PG Studies and Research,
University of Malaya,
Kuala Lumpur, Malaysia.
Attention: **Professor Dr. B. Vengadaesvaran**

(b) **If to SMM: Prof. Pravin Charde**
Principal, Sevadal Mahila Mahavidyalaya,
Sakkardara Square, Umrer Road,
Nagpur – 440024 (M.S.) INDIA
Attention: **Prof. Pravin Charde**
Tel. No.: +91-712-2705037; 2751344
Fax No.: +91-712-2705037

7. MISCELLANEOUS

(1) This MOU may be modified, varied or amended at any time after due to consultation and with the written agreement of both Parties.

(2) Each Party is an independent contractor and has no authority to bind or act on behalf of the other Party. Each Party is responsible and liable to the other Party only for its own acts and omissions, and the acts and omissions of its trustees, directors, officers, employees, and agents, relating to the industrial collaboration or to any materials or data that have been transferred to it in connection with the industrial collaboration.

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

(3) Nothing herein shall be construed as being such specific agreements and documents to implement the collaboration by the Parties and, if the Parties fail to execute such specific agreements and documents, neither Party shall have any liability to the other with respect to such transaction or such failure.

(4) Nothing contained in any discussions between the Parties or in any information disclosed by either Party as contemplated by this MOU shall be deemed to constitute a representation or warranty, except for the matters expressly specified in this MOU or the signed specific collaborative agreements and documents.

(5) This MOU is not intended to be legally binding. It merely expresses the intentions and understanding of the Parties which will form the basis of any legally binding agreement to be drafted and executed in the future.

(6) The Parties hereby agree that they are not bound exclusively by this MOU and shall be at liberty to enter into any separate agreements or arrangements with any third party without reference to the other Party.

IN WITNESS THEREOF, the Parties have caused this MOU to be executed by their duly authorized representatives.

Prof. Pravin Charde
Principal,
Sevadal Mahila Mahavidyalaya,
Sakkardara Square, Umrer Road,
Nagpur -440024 (M.S.) INDIA

Date: 12.02.2020

In the presence of:

Mrs A.S. Mahakalkar

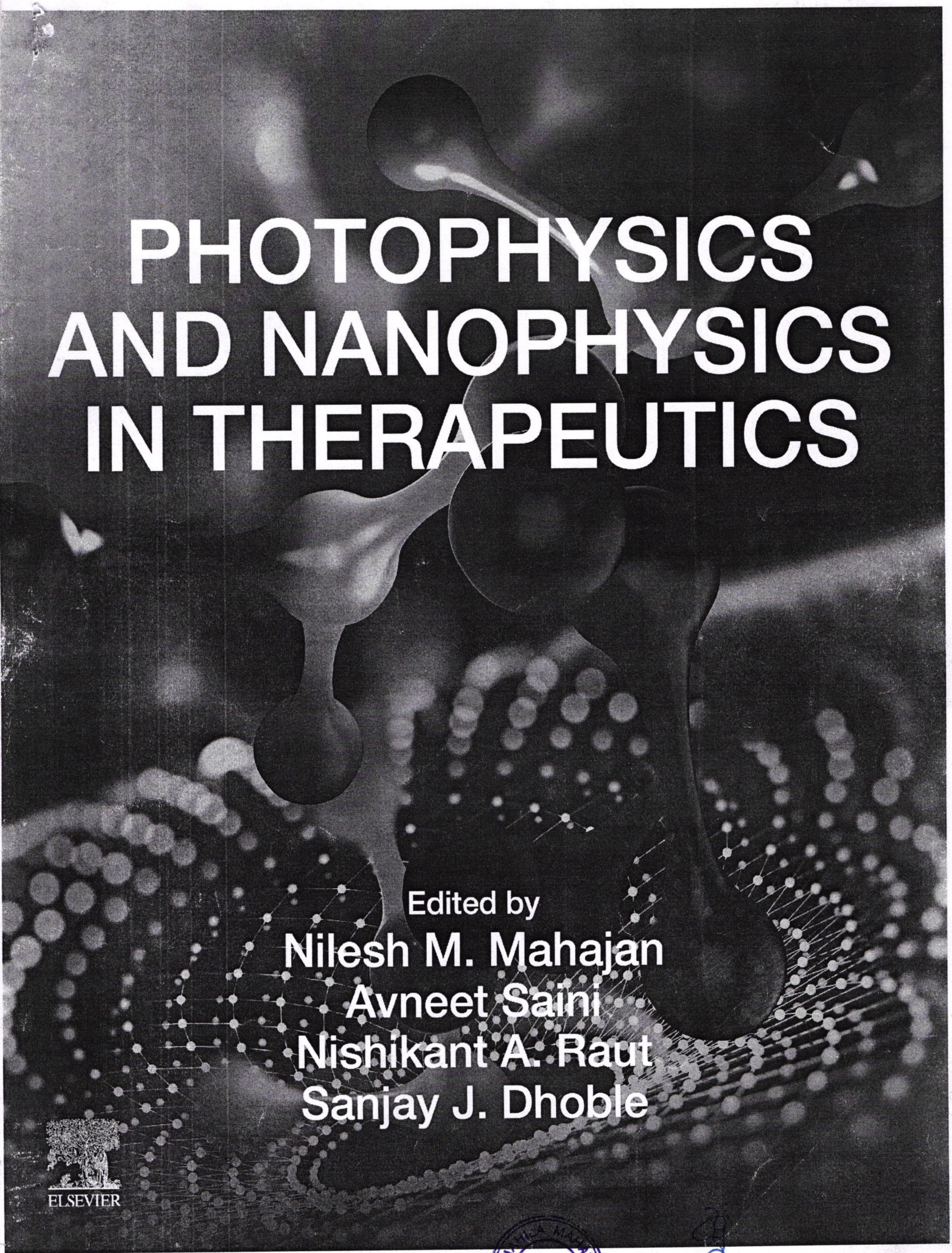
Dr. (Mrs.) A. S. Mahakalkar
Head, Department of Chemistry
Sevadal Mahila Mahavidyalaya, Nagpur

Dr. B. Vengadaesvaran
Research Director,
Advanced Materials Science Laboratory,
Institute of P.G. Studies and Research,
University of Malaya, Malaysia

Date: 12.02.2020

In the presence of:

Dr. (Mrs.) N. S. Dhoble
Associate Professor, Department of Chemistry
Sevadal Mahila Mahavidyalaya, Nagpur



PHOTOPHYSICS AND NANOPHYSICS IN THERAPEUTICS

Edited by
Nilesh M. Mahajan
Avneet Saini
Nishikant A. Raut
Sanjay J. Dhoble

ELSEVIER

Photophysics and Nanophysics in Therapeutics

Edited by

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Chapter 9

Role of carbon ion beam radiotherapy for cancer treatment

Vibha Chopra[a], **Nirupama S. Dhoble**[b], **Balkrishna Vengadaesvaran**[c], **Sanjay J. Dhoble**[d]

[a]*P.G. Department of Physics & Electronics, DAV College, Amritsar, Punjab, India*

[b]*Deaprtment of Chemistry, Sevadal Mahila Mahavidhyalaya, Nagpur, Maharashtra, India*

[c]*Higher Institution Centre of Excellence (HICoE), UM Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D University of Malaya, Kuala Lumpur, Malaysia*

[d]*Department of Physics, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra, India*

9.1 Introduction

A variety of materials are known for thermoluminescence dosimetric (TLD) applications with varying efficiencies for different R&D areas viz. medical (Efstathopoulos et al., 2003; Kron, 1999), accidental (Veronese et al., 2010), retrospective (Kazakis et al., 2016; Mesterhzy et al., 2012), personal (Gai et al., 2015), thermal neutron (Bhadane et al., 2016) dosimetry, solid state lighting (Dalal et al., 2016; Naik et al., 2016), and 2D OSL mapping (Oliveira et al., 2016). A large number of standard commercial dosimeters are available at national as well as international level which is also well-known under their commercial names for use in particular observed dose range. The most famous dosimeters developed are LiF: Mg, Cu, P (TLD-700H), Al_2O_3 (TLD- 500), $CaSO_4$:Dy (TLD-900) and CaF_2:Dy (TLD-200) and many more are expected to be available in the near future (Fox et al., 1988; Hasan et al., 1985; Noh et al., 2001; Sahare et al., 2007). Most of the phosphors can be used as TLDs within a specific range of radiation doses and are not applicable for all ranges of doses since their response depends on various factors viz. linearity, precision, dose rate, fading, reproducibility, and others. Thus, there is a need to explore more sensitive materials that show linearity of TL response up to wide range, energy independent, thermally stable and exhibit low fading. Moreover, there is a continuous increasing demand of efficient TL dosimeters to monitor high dose levels of swift heavy ions (SHI) since they are used for treatment of cancer and tumor cells. In this regard especially the doses from carbon ion beam are needed to be monitored as these ions are extensively used in medical applications (Kanagasekaran et al., 2008). The significance of the SHI ions over the older available technology of photon radio therapy lies in the fact that SHI delivers a better mean energy per unit length at a particular depth. SHI irradiation also results in the modification of the luminescence properties of the material by inducing defects because of huge energy deposition through electronic excitation (Wesch et al., 2004). In this view, number of reports are made by different groups on the thermoluminescence response of SHI exposed phosphors for high energy space dosimetry, ion beam dosimetry for personnel applications, radiotherapy, diagnostic purposes, etc. (Bedyal et al., 2016; Dutta et al., 2016; Kore et al., 2015; Kore et al., 2016; Som et al., 2014; Som et al., 2016; Yerpude et al., 2016). Research community is focused on the development of dosimeters for carbon ion beam therapy owing to its large number of benefits over gamma radiation therapy and proton therapy in the field of cancer treatment. Carbon ion beam radiotherapy was first used at the National Institute of Radiological Sciences (NIRS), Japan using world's first heavy ion accelerator complex (Heavy Ion Medical Accelerator in Chiba, HIMAC) in 1994. Currently, the facility is available in 13 centers worldwide and is under process for CIRT in Yamagata, Japan, and Yonsei University, Korea along with several facilities to be planned around the globe.

9.2 Radiation therapy for the treatment of cancer

Radiation therapy is usually a local treatment that affects only the cancerous part of the body to be cured unlike the other cancer-fighting drugs, that expose the whole body to radiations and causes harm to the healthy tissues as well. Commonly, electromagnetic and particulate radiation which includes X-rays, gamma rays, electron beams, proton beams, and ion beams are used in radiation therapy for the treatment of tumours.

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9.2.1 Gamma ray therapy

When radiation passes through matter it may interact with the material, transferring some or all of its energy to the atoms of that material. Gamma rays are absorbed or scattered causing number of processes. The prominent effects are Photo electric effect, Compton effect, and pair production (Knoll, 1999; Leo, 1994). Gamma rays interact with matter in different way as compared to charged particles due to greater penetration power and have no definite range. Unlike charged particles, a well collimated beam of gamma rays is exponentially absorbed in matter because photons are absorbed or scattered in a single event. The measurement of radiation dose of such beam is very important and essential as well. For this reason continuous efforts have been done by the research community around the globe for the development of new materials and to improve dosimetric properties of already available TLD materials as an efficient TLD which exhibits tissue equivalency (low Z_{eff}) as well as high Z_{eff} to ensure its use in low and high dosimetry (Emen et al., 2016; Gupta et al., 2016; Nyenge et al., 2016; Shivaramu et al., 2015). Further, nanomaterials are found to be more stable at high doses of gamma radiations, as their glow curve structure remains unchanged with dose and do not saturate even at very high doses where microcrystalline phosphors saturate (Chopra et al., 2013; Lochab et al., 2007; Salah et al., 2004; Salah et al., 2007; S.P. et al., 2007; Singh et al., 2011). So, in the current scenario research is mainly focused on the development of nanomaterials to be used as gamma dosimeters. In the past years, only Co-60 therapy was used for cancer treatment in the hospitals, hence only gamma ray dosimeters were explored, but later the ion beam therapy came into scene due to their advantages over Co-60 therapy. So, the current area of research is devoted to explore the dosimeters for proton and heavy ion beam therapy.

9.2.2 Proton therapy

Proton therapy is an emerging field in the area of research. It is considered as a highly effective treatment for tumors present in lung, prostate, brain, neck and head. Proton is a positively charged subatomic particle that deposits energy differently than X-ray beam and gamma ray. Compared to gamma or X-ray, the proton beam has a high dose 'bragg peak' region and low entrance dose that is designed to cover the entire tumor and not beyond that. So, by proton beam the dose is focused and delivered maximally to the malignant cancers tissue volume while minimizing the exposure to healthy tissues (Devicienti et al., 2010; Lawrence and Feng, 2013; Newhauser and Zhang, 2015; Podgorsak, 2006). Ionization chamber is the basic tool for dosimetry of proton beam therapy. However, various lithium fluoride based detectors, that is, LiF:Ti, Mg, LiF: Cu, Mg, P which are basically TL detectors are being widely used to measure the dose obtained from proton beam. Dosimetric studies of nanocrystalline boron based TL phosphors such as $Li_2B_4O_7$:Cu, MgB_4O_7:Dy have been performed using gamma rays and proton beam of energy 3 MeV, 150 MeV, electron beam of energy 4 MeV and 9 MeV respectively (Bahl et al., 2013; Chopra et al., 2014; Salah et al., 2013). Gamma rays and proton beam irradiated nanocrystalline $K_2Ca_2(SO_4)_3$: Eu phosphor is also reported to exhibit very good TL properties (Pandey et al., 2011). Since the proton therapy possesses very low risk of showing adverse effects, so, it is a clear choice of treatment in near future and there is a very wide scope to find best suitable TL dosimeter for proton beam therapy.

9.2.3 Ion beam therapy

The field of therapy with ions is maturing rapidly. Ion beams are being used as ultimate tool to cure very advanced hypoxic as well as radiation resistant tumors having complex local spread. Ion beams are heavier, their trajectories are stiffer, they have less multiple scattering, less range straggling, more favorable dose deposition profile, thus the normal healthy tissues beside the surrounding of cancerous tissue are exposed to very less energy of ion beam. Ion beam on entering the target material simultaneously interacts with many electrons causing excitation and ionization of its atoms. Charged ion transfers its energy to the electron, as a result it slows down due to decrease in its velocity. The average energy loss per unit path length is known as the stopping power or simply dE/dx. It was first calculated by Bohr using classical mechanics and later corrected by Bethe, Bloch, and others using quantum mechanics. A plot of specific energy loss along the track of charged particles, that is, distance of penetration is known as Bragg curve. The heavy ions shows sharp bragg peak. Different research groups have reported and investigated the TL response of SHI irradiated phosphors for high-energy space dosimetry, radiotherapy, personal dosimetry and diagnostic purposes in clinical use etc. (Dutta et al., 2016; Kore et al., 2015; Kore et al., 2016; Som et al., 2016; Som et al., 2014; Yerpude et al., 2016). C^{5+} ions being heavier charged particles than constituent particles present in conventional radiation sources ensure more focused penetration with minimum scattering to the tumor even located deep inside the body. Thus carbon ion beam therapy plays very important role in the field of radiotherapy. So, the scientists all around the world are in search of dosimeters for carbon ion beam therapy.

Chapter 9

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Vibha Chopra[a], Nirupama S. Dhoble[b], Balkrishna Vengadaesvaran[c], Sanjay J. Dhoble[d]

[a]*P.G. Department of Physics & Electronics, DAV College, Amritsar, Punjab, India*

[b]*Deaprtment of Chemistry, Sevadal Mahila Mahavidhyalaya, Nagpur, Maharashtra, India*

[c]*Higher Institution Centre of Excellence (HICoE), UM Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D University of Malaya, Kuala Lumpur, Malaysia*

[d]*Department of Physics, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra, India*

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Ref. No. 153
Dated 11-8-2021

Dr. (Mrs) Nirupama S. Dhoble,
Professor,
Sevadal Mahila Mahavidhyalaya,
Nagpur

Esteemed Madam,

I express my deep sense of gratitude to you for your sagacious presence as **Invited Speaker** at International Webinar on the topic **"Future Materials: Scope and Challenges"** on June 10, 2021 by the Postgraduate Department of Physics.

Madam, your towering presence on this occasion and your words of wisdom and encouragement will go a long way to motivate and inspire the students to scale new heights.

We hope, you will continue to bestow your kind blessings on our youth in future as well.

May Almighty bless you with greater strength, health and prosperity to serve the nation for many more decades to come.

Thanking you,

Yours sincerely,

(Dr. Rajesh Kumar)
Principal

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SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

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