

Organoselenium-Based BOPHY as a Sensor for Detection of Hypochlorous Acid in Mammalian Cells

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Abstract – With the development of normal optoelectronic materials and bioimaging development, to take gain of traditional wonderful materials with immoderate exceptional execution in all-out us of has emerged as an exams area of the hobby. BODIPYs have emerged as one of the examinations gadgets of this type of floor in mild in their affordable advantages. This format makes a robust factor of the configuration and mix of AIE-type BODIPYs, the part of AIE houses, and their organizations in modern-day years. Through request, examination, and overview, this format facilities to find out the plan aspect hobby courting of AIE-type BODIPYs and to talk impressions for the equivalent employer and cutoff hundreds of AIE-lively fluorescent materials.

Keyword – OLED, BODIPY, Intermolecular Development Constraint (IMR), Aggregate Caused Disposal (ACQ).

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1. INTRODUCTION

Regular everyday fluorescent tones with a π -framed plan display bewildering notable houses in the debilitating path of motion but grow to be weakly or non-emissive in especially crammed publications of motion or within side the country of assortment that is called the impact of aggregate caused disposal (ACQ). This impact is an instantaneous result of the twist of fate among the floor country and the empowered country of the extensive idea fluorescent molecule, which activates the deactivation cycle without radiation, or thinking about the manner that the sturdy correspondence among the planar shape tool and the true activates the path of motion of excimers or exciplexes, and the electricity of the inspired country lessens within side the non-radioactive construction [1]. It's been significantly diagnosed as one greater framework to direct the ACQ sway on OLMs. Moreover, tetraphenylethylene (TPE, Figure 1) all-around have very tangled plans and display low fluorescence in debilitating publications of motion because of the intermolecular (IM) - actuated non-radioactive alternate of their inspired country. In absolutely the express, those IM sorts of development are satisfactorily smothered, accomplishing an addition of their spread. There are several latest development initiated one of them is BOPHY, a novel fluorescent chromospheres, may be easily produced in two stages using widely available chemicals by combining pyrrole-2-carboxaldehyde with hydrazine and then reacting with BF₃. The resulting symmetric and dimeric teracycle is made up of two BF₂ units in

six-member chelate rings that are surrounded by parole units [2]. In CH₂Cl₂, the quantum yields of fluorescence for the unmodified chemical and the tetraethyl version are close to unity, with values of 95 and 92 percent, respectively. We used cyclic voltammeter and density functional theory to investigate the electrical structure of this molecule [3]. Also outlining the progress achieved in organ selenium chemistry during the previous three years, with an emphasis on catalytic performance, greener characteristics, their involvement in asymmetric synthesis, and their capacity to offer critical intermediates viable for subsequent organic transformations.

1.1 Superoxide

A creating collection of confirmation suggests that ROS (superoxide and hydrogen peroxide) are made in various harmful development cells and accept a significant part in hailing the fundamental cell increase. Low centralizations of superoxide or hydrogen peroxide energize cell improvement and the advancement response in a grouping of refined mammalian cells. Hailing pathways are shown between cell improvement responses impelled by superoxide and hydrogen peroxide. Cellular responses to cytokines and advancement factors, and have been displayed in the disclosure of the assertion of the offenders, including CFOC, CMYC, and CJUN epidermal cells, superoxide starts incitation.

1.2 Detection of superoxide's

We have definite the oncosuppressive effects of manganese-containing superoxide dismutase (MnSOD) in human chest dangerous development cells. Maspin is a person from the protease inhibitor gathering of serpent which has been exhibited to be effective as a development silencer in human mammary epithelium. In the current audit, we showed that mapping explanation was unregulated in human chest harmful development MCF7 cells. Which over express a common MnSOD quality? The incited mashing records were perceived by RTPCR and Northern blot and recognized by sequencing. Enunciation of the Maspin quality was activated in relating with the level of exogenous MnSOD protein, which was incited by transfect ion with moving proportions of cDNA. To take apart the cutoff regarding cell assault, which can be associated with the incited verbalization of the maspin quality, stable MnSOD transfect ants were had a go at using a madrigal interruption chamber.

1.3 ROS (Reactive oxygen species)

Responsive oxygen species (ROS *) are the endogenously made symptoms of all high-sway cells on account of oxygen absorption. ROSs is astoundingly open and at high obsessions applies destructive ramifications for living natural substances, including damage to DNA and cell layers. At low obsessions, a couple of ROS go probably as central intracellular second messengers in cytokine hailing pathways and advancement factors. ROS are displayed to signal the assertion of proto-oncogene including cost, cmyc, cjun, and superoxide progressives are related with ras-started cell cycle development liberated from the MAPK and JNK pathways.

1.4 BODILY (C₉H₇BF₂N₂)

These insights drove us to test the hypothesis that the phone phenotypic changes instigated by MnSOD and the block of malignancy improvement in vivo are associated with the outpouring of the development of silencer quality (s), explicitly protease inhibitors. In the current survey, we showed extended endogenous enunciation of the mashing quality in MnSOD cells over expressing MCF7.

1.5 Breast Cancer Cell

Cell security from the cytotoxic effects of TNF α as well as hyperthermic stress was also extended in MnSOD transfect ants. These results recommend that MnSOD may fill in as a development silencer quality in human chest sickness cells. Hailing pathways in MnSOD brief cell phenotypic changes and covering of disease interruption improvement ought to be also clarified. Changes in twelve development silencer characteristics have been associated with the improvement of danger in individuals. Regardless, these quality things were for the most part not found to

impact malignancy interruption and metastasis. Proteases and protease inhibitors expect a critical part in conventional tissue headway and a lopsidedness of these two kinds of proteins is locked in with malignant growth interruption and metastasis. It is basically imparted in regular chest epithelial cells anyway is either indistinct or conveyed. At outstandingly low levels in a couple of chests.

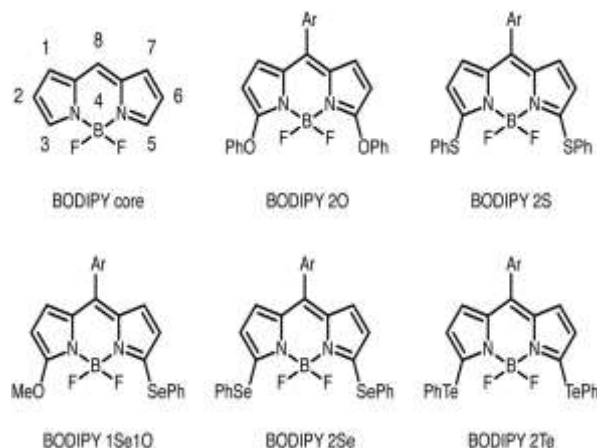


Figure 1: Structure of BODIPYs

(Source: pubs.rsc.org)

Tragically, in comparison to their outstanding radiance in arrangement, maximum BODIPYs revel in the unwell consequences. Along those lines, the development of BODIPY with collected fluorescence has gotten excessive attention in past due many years. AIE has proven to be a procedure. Various dynamic AIE BODIPYs had been usually deliberate through exceptional procedures, for example, direct incorporation of AIE debris with the BODIPY spine, J-kind overall, and alternate of the dipyrromethene bidentate ligand. The upsides of IEA, the intense fluorescence of the whole territory of BODIPY had been efficiently accomplished. Likewise, their software as manufacturers of series states for bioimaging, increase response switches and OLEDs has been demonstrated. This little audit facility round gives a definition of the plan, device, and use of AIE active BODIPYs and BODIPY analogs to paintings with their destiny software in robust nation glow. For simplicity of clarification, AIE active BODIPYs are partitioned into classifications: one relies upon at the boron dipyrromethene stage (exemplary BODIPY); the opposite is the BODIPY analogs depending on bidentate chelates depending on heterocycles. Key photophysical facts for every compound.

2. RESEARCH REVIEW

According to Martínez-Martín, 2017, NMR spectroscopy and mono XRD were used to analyze phenylselenide modified BOPHY probed (BOPHY-Seph or PhSe-BOPHY-Seph). All electrodes detect HOCl in water with good effectiveness while ignoring other oxidative stress. The end of the PET process resulted in a brightness "turn-on" event owing to the transition of selenide to selenoxide. All needles

respond with HOCl in even less than one second. Because of the presence of two phenylselenide molecules at BOPHY, the PhSe-BOPHY-Seph probe displayed deep background fluorescence. The concentration range of the PhSe-BOPHY-Seph probe is lower (0.63 M) than that of the BOPHY-Seph probes (1.08 M). All devices' bioimaging experiments were conducted in MCF 7 cells. In addition and in animal cells, both probes showed a strong fluorescence response to HOCl. Furthermore, the probes demonstrated reversibility among all plants, which also was confirmed in MCF 7 lines utilizing GSH.

According to F. Etoc, 2018, the Overall AIE behavior of TPEBODIPY is unmistakably determined by the location and number of TPE devices associated with the Chromophore center. For example, we specified whether BODIPY henchmen with TPE or revisiting gadgets at locations 2,6 or 2,6, eight, Amount 2) should adequately suppress ACQ and pass around as development of series produced outflows. (IAEA). Regardless, the development of TPE at role 3 occurs [5]. Seven of the BODIPY intermediates produced huge-shaped objects with ACQ. Due to the obvious significant digital communication between TPA (D) and BODIPY (A), this expansion is mostly stifled by the dipole action. Therefore, when the few landed upon this mark of aggregation, the upheaval of aromatic jewelry grew skillfully limited, bringing about a broad absorption and AIE expulsion (Figure 4). Furthermore, intensities 12-14 with TPA gadgets connected in positions 2, 2,6, 2,6, eight demonstrated a more advanced TICT impact than intensities twelve, and only the creation of triggered TICT manifestations.

According to Pak, 2018, Hypochlorous acid (HOCl), a well-known universal disinfectant in therapeutic practise, plays critical functions in animal and human immune systems. A variety of methods, including chemiluminescence, colorimetric, electrochemical, and molecular biology, have been used to better understand the roles of HOCl in biological systems. Chromatographic techniques have been investigated. Cutting-edge approaches, such as fluorescence/phosphorescence molecular probes and responsive nanopropes, are being used to detect HOCl in living organisms. Recently, Raman and activatable photoacoustic sensors have also been created.

According to X, 2020, Glutathione (GSH) and protein complexes are quickly oxidized, making them ideal targets for tiny, sublethal quantities of HOCl. Thiol enzymes' susceptibility to HOCl varies, with glyceraldehyde-3-phosphate converter being the most sensitive. Indeed, activity was lost before utilization oxidation. The results of these processes, as well as cells' capacity to repair oxidized disulfide bonds, are reviewed. Recent research has shown that HOCl may activate cell signaling pathways, and these findings could shed light on the oxidant's function in irritation. Responsive oxygen species (ROS *) are endogenously produced by all high-sway cells as a

result of oxygen absorption. ROSs is astonishingly open and, in large concentrations, have harmful effects on living natural substances, including DNA and cell layers. Mitogenesis induced by ROS, disease progression, and neoplastic change at low concentrations, a handful of ROS is likely to operate as important intracellular second messengers in cytokine signaling pathways and progression factors. ROS such as cost, cmc, cjun, and superoxide is produced to signify the presence of a proto-oncogene [4]. Progressives are linked to ras-activated cell cycle development freed from the MAPK and JNK pathways.

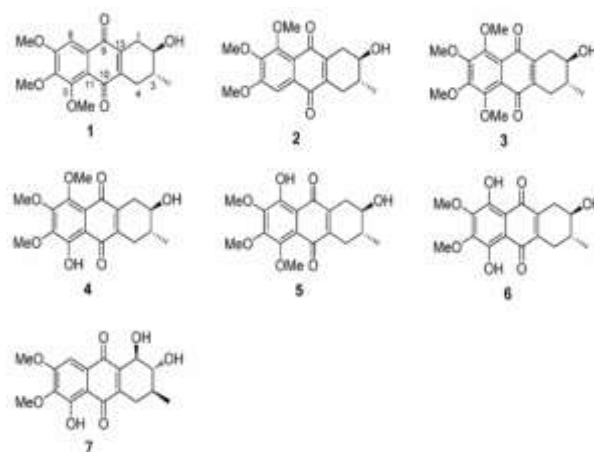


Figure 2: CHEMICAL STRUCTURE OF COMPOUNDS 1-7

(Source: researchgate.net)

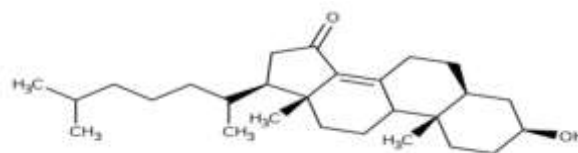


Figure 3: CHEMICAL STRUCTURE OF COMPOUNDS 8-14

(Source: fishers.fi)

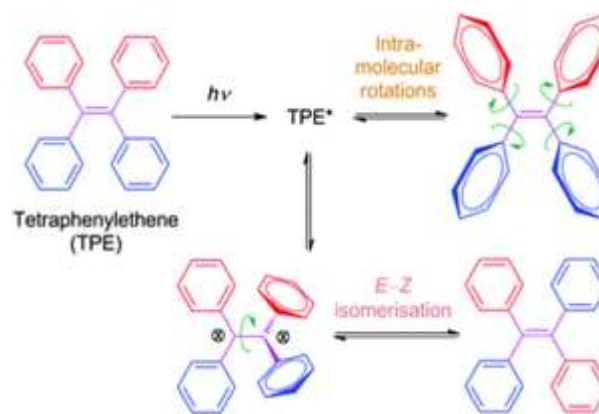


Figure 4: MECHANISM OF AIE

(Source: pubs.rsc.org)

Most BODIPYs will present the H-type (closer and personal) totals within the UN in a trending form, which activates the fluorescence quenching. And in this way, they could give off a comparative red-shifted flow with their separate monomers. Under this conglomerate, the developing monomer dipoles adjust in a coplanar BODIPY cycle, for example, paracyclophane (15, figure five) and adamantyl bouquet should be painted with improved overall emissivity totals. It improved total emissions BODIPY, Kim and al [7]. It completed a planned search for the substitution effect on the mispositioning. The improvement in total emissions could be very sensitive to small changes in number one. No conglomerate transformed into determined within the three, 5dimethyl subordinates. Also, through the way of using the meso ester subbed BODIPY, take a look at AIEEtype 17b, they understood the will to explicitly select HOBr produced by eosinophilic peroxidase (EPO) means for a selected initiation signal: the self-accumulated purple emission totals of 2.6 dibromine 17b (621 nm) in cluster orange products (581 nm).

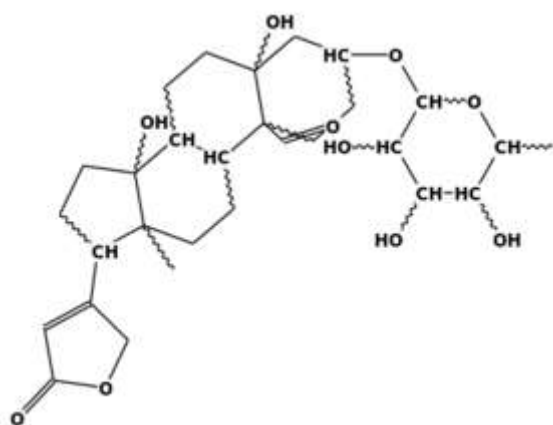


Figure 5: Chemical Structure of Compounds 15-22

(Source: webbook.nist.gov)

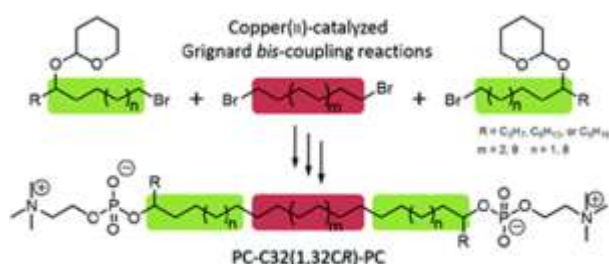


Figure 6: Different aggregation behavior of 17a

(Source: pubs.rsc.org)

Despite the aforementioned set of aggregation manipulations via the type of meso-substitution in OBODIPY with a model of Bspiranic 4,4diacyloxy substitute (Figure 5). The excessive conformational stiffness of this plane is simply because the symmetrical motion path of the Bdiacyloxy substituent and the meso-aryl group have been tested as key additives at some point in time Jaggregation. Wang et

al. focused on spiro BODIPY with a unit of diaryl chelate that can total body J in the liquor and water mixture. The total Js of 20a confirmed better flow productivity as well as those of 21a and 22a confirmed a decrease in the discharge efficiency, showing that the adaptation of the emanation energy is a virtually now it n 'is more of a reliable marker for[8]. The comparative additives under beds with medium-functional phenyl (20b22b) are no longer visible within the agglomeration association of the water-liquor mixture or the water-tetrahydrofuran mixture. The total process created patterns of over-discharge in the state of accumulation. Aside from the BODIPY specimens, the recent development of the BODIPY family, to be the unique analogs of BODIPY with AIE active, will surely lead to an advanced understanding of the wonders and provoke new applications.

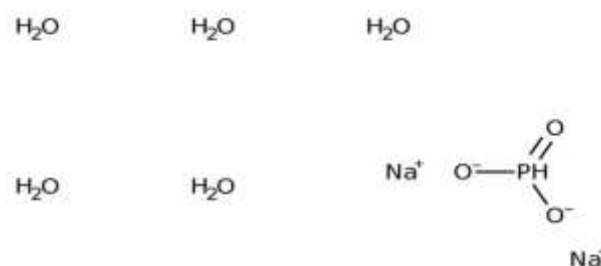


Figure 7: Chemical Structure of Compounds 23-26

(Source: fishersci.se)

3. METHODOLOGY

NIREmissive azaBODIPYs are still an undetectable level benzo [d] thiazolidinedione ligand differentiated by a mechanism for connecting selected TPE fractions to its framed geometric enhancement. Even during the formation of the embrittled methylene chloride, mixtures 24 and 25 exhibit a minor fluorescence with f of 0.7 and 0.4 percent, respectively chemical 25) as a result of the accumulation of incorrect emissions statistics. AIE dynamic az otropi with significantly distorted augmentation. Compound 26 stated to have elegantly consumed blue, which led to the voyage being suffocated due to the impact of modified TIC. Eventually, consciousness considerations of shipments went beyond 480 to 610nm linked by the overloaded restoration approach by contemplating on the growth of aggregates made apparent. Aside from the AIE gadget circuit methods and techniques in body awareness and intensification organization, the addition of monodentate dipyrromethene to deliver BODIPY analogs with antisymmetric and fibril advancement was also a productive machine to attain AIEdinamica BODIPY with a variety of nations f. In general, albeit dangerous, these BODIPY analogs display additional Stokes shift from the usual BODIPY, which is advantageous in hiding personality during the mixture. Similarly, as a benefit of their convoluted arrangement above, the strong joint effort could be effectively avoided from the start

above, the AIE dynamic BODIPY analogs with the better propeller were created using a dipyrrole method replacement [6]. This capacity of macrophages and neutrophils to eliminate a wide spectrum of pathogens is dependent on the formation of strong acids (HOCl) via the polyphenol oxidase system. The production of a powerful oxidant, on the other hand, is not without risk to the host, and there is evidence that HOCl contributes to the tissue harm inflammatory disease. In this paper, we explore HOCl's pharmacological reaction and what has been known about how it interacts with animal cells. The consequence of oxygen exposure is dosage dependant, with greater concentrations producing destruction and lesser levels inducing apoptosis or inhibition. With either a lower insulin quantity, hypochlorous acid (HOCl) plays an important part in microbial killing and pro-government in innate immunity. Variation from the usual concentration is closely connected to inflammatory illnesses, including cancer. As a result, it is important to detect even the smallest variations in HOCl concentration. Yet, because of modest Stokes shifts, strong identification of limits, and poor SNR, only a handful of the described probes may perform realistically effectively. HBT (2-(2'-Hydroxyphenyl) benzothiazole) was utilized as the alternative for the ESIPT-based fluorescent in this work, and it was linked to pyridine via "C C" bonds. The HOCl reaction site is the "C C" bonds, which are triggered by the significant acceptors CN group situated for double carbon, resulting in a greater sensitivity to HOCl. As a result, the probe's output efficiently moved to the red channel, eliminating influence from cell autofluorescence[10]. The probe JBD's good reactivity to HOCl allows it to monitor spontaneous hypochlorous acid in cells, making it a suitable statistical tool for studying the mechanisms of hydroxide ions in oxidative stress.

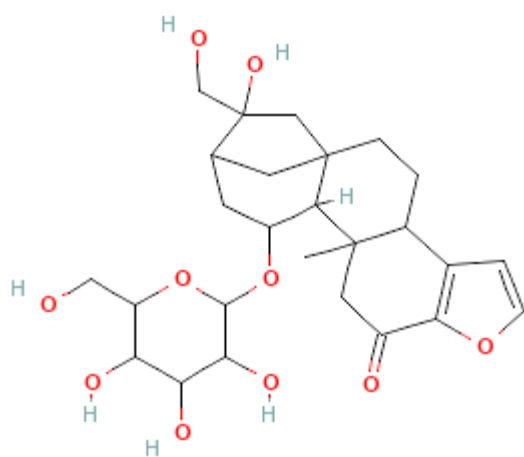


Figure 8: Chemical Structure of Compounds 27-36

(Source: pubchem.ncbi.nlm.nih.gov)

Driven by the problem of the AIE dynamic BODIPY analogs to pyridine hydrazones lagans, a set of the most recent difluoride structures of monobrow and Birdsboro AIE dynamic AIE was produced by the

addition of benzo [d] diazole hydrazones on the basis that chelates[11]. Like compound 27a, these frameworks claimed low transmission (Φ_{elt} ; 1%) and surprising Stokes changes (up to 7,400 cm^{-1}) in a weakened and AIEE manner in the hard and fast country. The direct AEI of these houses has been studied and noted to be closely related to the RIR of scent rings [12]. Considering the intriguing places of hetero-cyclo amidine and hetero-cyclo hydrazone ligands based primarily on absolutely BODIPY analogs, it is worth expanding the assortment of these BODIPY analogs to present themselves as the most outstanding AIE dynamic logic substances. For the general situation, the problem of BODIPY analogs exceptional for hetero cyclone enol legends had adequately evolved. Matsui et al. mixed a framework of boron difluoride derived from β benzo [d] thiazole enolate ligands (30, Figure 8). Thinking of this principled work, Matsui et al. also studied the photophysical loci and AIE of the problem of structures from the mono bore and bis-boron to pyrimidinone ligands (31, figure 8). By adjusting the TC and the influence of the enhancement, an extraordinary first-order nationwide flood, the most extreme, from 488 to 641 nm was refined ($\Phi = 7-20\%$). Thus, outstanding helix-shaped BODIPY analogs emit pyridine, quinoxaline, pyramid, and benzo [d] thiazole enolate ligands (Figure 8) were processed through unique social events. Like HPS and TPE, the helix-like arrangement quenched the release of such structures in a way incapable of development and, with the result of confining the intramolecular gyrus through the assortment, an obvious AIE lead was observed.

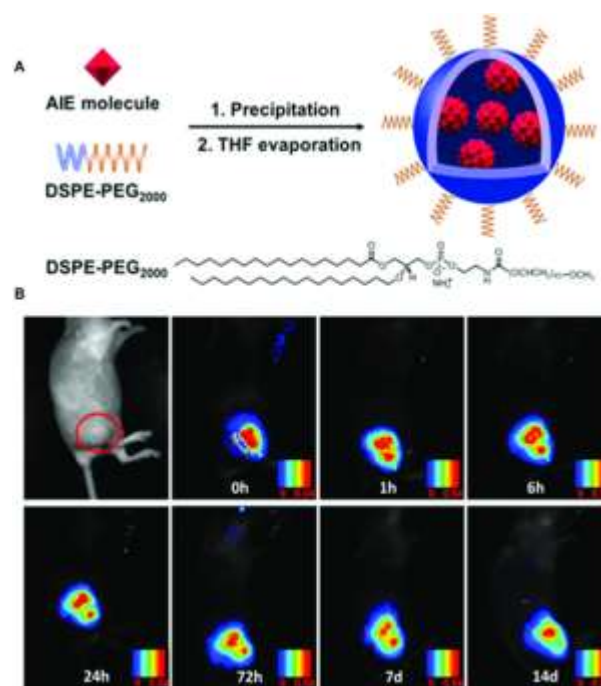


Figure 9: Preparation of the AIE NPS of compound 12

(Source researchgate.net)

Mechanofluorochromic (MFC) Materials

MFC materials that change gloss during mechanical hammering/cutting have received a lot of interest due to their promising applications [14]. In general, AIE particles with a solid skeleton twisted with rotating aryl units, realizing the stacking of free atoms insignificant stone state, can be easily destroyed by mechanical stimulation, obtaining a qualification in the tone of splendor [15]. The indistinguishable change in 26 glass-like clear states during granulation and smoky refresh measurements was shown by Xbar powder diffraction (PXRD).

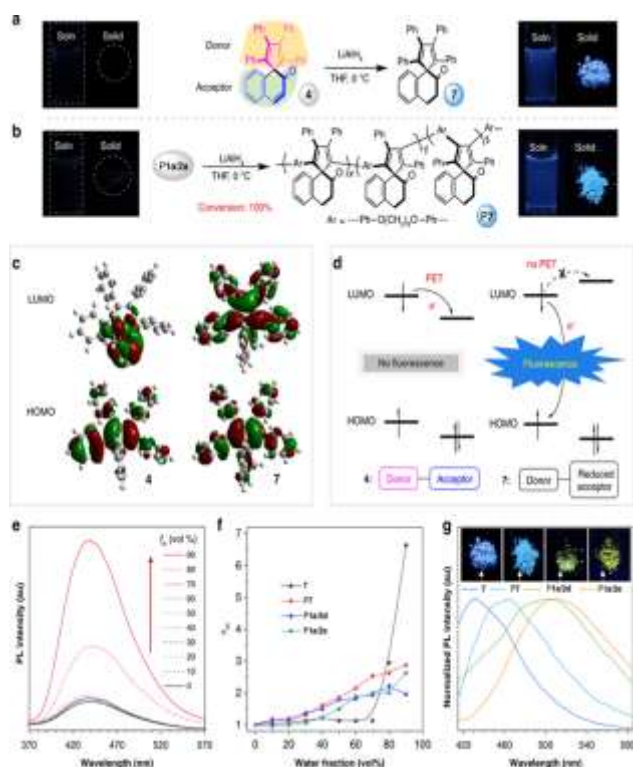


Figure 10: Photographs of the powder of the compound

(Source researchgate.net)

It inferred that the subordinate strain intermolecular affiliation and the influence of computed tomography were convincing to stimulate piezoceramic splendor (Figure 11). The particular piezoceramic impact of low strain 35f suggested that the AIE phosphor formed by the helix with the ICT impact might be a basic explanation for the planning of high influence MFC [16]. We have acknowledged that metachrosis is attributed to the asymmetrical helical arrangement and the acceptor character of the advertiser of 33d.

Due to their strong solid fluorescent properties, AIE dynamic BODIPY and their analogs are offered as ideal possibilities for gas recognition. Various mixtures have been considered as fluorescent switches for typical soluble, ruinous, and basic gases. For example, boost 34a - and had a surprising direct acid

chromic reaction triggered by noxious smoke. After reactivity to ruinous trifluoroacetic discharge (TFA), the shades of 34ae became opaque and the assimilation spectra were redshifted and united by a strong luminosity blanket [18]. The impact of suffocating fluorescence on ruinous smoke must be attributed to the synergistic impacts of nitrogen protonation which occurs given the push-pull influence induced by the pyrazine zone and developments in intermolecular pressure and from atomic consistency to harmful protonation.

3. CONCLUSION

There is a huge side withinside the evaluation of dynamic IEA BODIPYs with NIR transmission (seven-hundred-1, seven-hundred nm). Veered from the huge quantity of dynamic AIE BODIPYs with quick unfold repeat, the powerful occasions of NIR overflowing are quite bound. Assessment of the right plan rectangular and converting of the development upgrades should be good-sized in acquiring the advent of the NIR accumulating country. the destiny of medical and in vivo imaging. Together, below the power of IEA, fruitful accumulating country emissive BODIPYs with extraordinary designed plans and fascinating photophysical residences might be made. These BODIPY helpers will irrefutably display their skills in extraordinary fields of use.

REFERENCE LIST

Journal

- [1] Martínez-Martín, D., Fläschner, G., Gaub, B., Martin, S., Newton, R., Beerli, C., Mercer, J., Gerber, C. and Müller, D. (2017). Inertial picobalance reveals fast mass fluctuations in mammalian cells. *Nature*, 550(7677), pp. 500-505.
- [2] F. Etoc et. al. (2018). "Non-specific interactions govern cytosolic diffusion of nanosized objects in mammalian cells", *Nature Materials*, vol. 17, no. 8, pp. 740-746, Available: 10.1038/s41563-018-0120-7.
- [3] H. Feng et. al. (2018). "Responsive Fluorescence Probe for Selective and Sensitive Detection of Hypochlorous Acid in Live Cells and Animals", *Chemistry - An Asian Journal*, vol. 13, no. 18, pp. 2611-2618, Available: 10.1002/asia.201800957.
- [4] X. He et. al. (2020). "Synthesis and biological evaluation of organoselenium (NSAIDs-SeCN and SeCF₃) derivatives as potential anticancer agents", *European Journal of Medicinal Chemistry*, vol. 208, p. 112864, Available: 10.1016/j.ejmech.2020.112864.

- [5] A. Al-Tamimi et. al. (2019). "Discovery of new organoselenium compounds as antileishmanial agents", *Bioorganic Chemistry*, vol. 86, pp. 339-345. Available: 10.1016/j.bioorg.2019.01.069.
- [6] Y. Attia and S. Abdel-Hafez (2018). "One-step synthesis of photoluminescent catalytic gold nanoclusters using organoselenium compounds", *New Journal of Chemistry*, vol. 42, no. 12, pp. 9606-9611, Available: 10.1039/c8nj00919h.
- [7] Ogata, M., Hoshi, M., Urano, S. & Endo, T. (2000). Antioxidant activity of eugenol and related monomeric and dimeric compounds. *Chem. Pharm. Bull. (Tokyo)*. 48, pp. 1467–1469.
- [8] Pisano, M. et. al. (2000). Antiproliferative and pro-apoptotic activity of eugenol-related biphenyls on malignant melanoma cells. *Mol Cancer*
- [9] Asha, M. K., Prashanth, D., Murali, B., Padmaja, R. & Amit, A. (2001). Anthelmintic activity of essential oil of *Ocimum sanctum* and eugenol. *Fitoterapia* 72, pp. 669–670.
- [10] Opdyke, D. L. (1975). Monographs on fragrance raw materials. *Food Cosmet. Toxicol.* 13, pp. 545–554.
- [11] Hinnen, C., Ranchor, A. V., Baas, P. C., Sanderman, R. & Hagedoorn, M. (2009). Partner support and distress in women with breast cancer: The role of patients' awareness of support and level of mastery. *Psychology & health* 24, 439–455, doi: 10.1080/08870440801919513.
- [12] Sarrami, N., Pemberton, M. N., Thornhill, M. H. & Theaker, E. D. (2002). Adverse reactions associated with the use of eugenol in dentistry. *Br. Dent. J.* 193, pp. 257–259, DOI: 10.1038/sj.bdj.4801539.
- [14] Barkin, M. E., Boyd, J. P. & Cohen, S. (1984). Acute allergic reaction to eugenol. *Oral Surg. Oral Med. Oral Pathol.* 57, pp. 441–442.
- [15] Vilaplana, J., Grimalt, F., Romaguera, C. & Conellana, F. Contact dermatitis from eugenol in mouthwash. *Contact Dermatitis* 24.
- [16] Murakami, Y. et. al. (2012). Comparative inhibitory effects of magnolol, honokiol, eugenol and bis-eugenol on cyclooxygenase-2 expression and nuclear factor-kappa B activation in RAW264.7 macrophage-like cells stimulated with fimbriae of *Porphyromonas gingivalis*. *In Vivo* 26, pp. 941–950.
- [17] da Silva, P. T. et. al. (2008). Cytotoxicity evaluation of four endodontic sealers. *Braz. Dent. J.* 19, pp. 228–231.
- [18] Huang, F. M., Tai, K. W., Chou, M. Y. & Chang, Y. C. (2002). Cytotoxicity of resin-, zinc oxide-eugenol-, and calcium hydroxide-based root canal sealers on human periodontal ligament cells and permanent V79 cells. *Int. Endod. J.* 35, pp. 153–158.
- [19] Zhang, R., Song, B. and Yuan, J. (2018). Bioanalytical methods for hypochlorous acid detection: Recent advances and challenges. *TrAC Trends in Analytical Chemistry*, 99, pp. 1-33.
- [20] Jia, H., Xia, S., Feng, H., Meng, Q., Duan, C., Zhang, Z. and Zhang, R. (2018). A fast response fluorescence probe specific for hypochlorous acid detection and its applications in bioimaging. *Organic & biomolecular chemistry*, 16(12), pp. 2074-2082.
- [21] Pak, Y.L., Park, S.J., Wu, D., Cheon, B., Kim, H.M., Bouffard, J. and Yoon, J. (2018). N-Heterocyclic Carbene Boranes as Reactive Oxygen Species-Responsive Materials: Application to the Two-Photon Imaging of Hypochlorous Acid in Living Cells and Tissues. *Angewandte Chemie*, 130(6), pp. 1583-1587.

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