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A Study on Materials for Luminescent Concrete Pavement

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A B S T R A C T

It is seen that these days we have colossal utilization of concrete and furthermore power around the world. It is announced that concrete is the second most utilized material on the earth. Here, the thought is to take full advantage of the two of them by lessening the utilization. There came out the hypothesis of iridescent cement by involving a few materials in concrete, we can really make it radiant. The hypothesis of brilliant cement is supplanting LP Powder and RP Powder in the concrete substantial asphalt. This is extremely useful to decrease the power at evenings. The materials utilized in this are useful to store the energy at the day time and brilliant around evening time. This iridescent substantial aides in lessening the wastage of power during evenings. The increment of LP content can work on the radiant properties of SLCPM, and the examples can keep great luminosity in the wake of lighting 8 h; albeit the increment of the RP affects working on the underlying brilliance of SLCPM, it can further develop the phosphorescence execution and draw out the glimmer season of SLCPM. The fitting molecule size of LP and RP can work on the mechanical strength of concrete based brilliant materials partially, while the expansion of LP with exorbitantly little or enormous particles unfavorably influences the strength of the LCCM example, and the ideal LP molecule size is 200 lattice. The excitation frequency scope of the LCCM was 350-450 nm. The pinnacle frequency of the outflow range was in the reach 510-520 nm, and the variety was yellowish green that will be apparent to the natural eye in dull.

Keywords: Luminescent powder, Reflective powder

1. INTRODUCTION

As per many investigates it is seen that these days we have colossal utilization of concrete and furthermore power around the world. It is proclaimed that concrete is the second most utilized material on the earth. The hypothesis of iridescent cement is supplanting LP Powder and RP Powder in the concrete substantial asphalt. The reason for street lighting is to give traffic security and direction to drivers and walkers, however the huge scope utilization of street lighting offices achieves expanding energy utilization. As indicated by measurements, the power utilization of street lighting represents around 20% ~ 30% of the all out power utilization of public lighting, while the power usage rate is under 65%, which is a serious waste. The glare brought by conventional road lighting will cause the driver and traveler visual uneasiness and weakness, and in any event, achieve security risk in serious cases. The self-brightening of street surface can be acknowledged by worked in light gadget or adding iridescent materials. Glowing cement is a kind of substantial which is a combination of white portland concrete, radiant powder, Intelligent powder, Hydrophobic materials. This is exceptionally useful to diminish the power at evenings. The materials utilized in the planning of this glowing cement are useful to store the energy at the day time and transmit the energy around evening time. This brilliant substantial aides in decreasing the wastage of power during

2. LITERATURE REVIEW

Yingli Gao et.al, (2017)

a directed "Concentrate on properties and components of radiant concrete based asphalt materials with super-hydrophobic function."[1]In other review, super-hydrophobic and glowing concrete asphalt materials (SLCPM) were ready, and the impacts of the long phosphorescence brilliant materials and hydrophobic materials on iridescent properties and hydrophobicity of SLCPM were examined. The long glimmer radiant materials can be ordered into sulfide, aluminate, silicate and other lattice types as per its creating cycle and different network [2,3].Some have likewise centered around the photoluminescence properties of the durable glow materials co-doped Eu2+ and Dy3+, and the outcomes show that Dy3+ exists in the phosphors under proceeding with excitation at 175 nm [4,5].Some researchers have applied super-hydrophobic materials to the asphalt, and it was found that utilizing super-hydrophobic materials could drag out the icing time and diminish the holding strength among ice and street [6,7].

Bailin Shah et.al,(2022)

"Planning of High-Glow materials and utilization of Iridescent coatings in street engineering"[8] In other review, SrAl2O4：Eu2þ, Dy3þ long-phosphorescence materials were ready by the strong state response technique. The glowing properties were further developed by changing the interaction boundaries. Long-luminosity material is a sort of photoluminescent material, which can store energy when it is illuminated by light and keep on radiating light after the excitation stops to acknowledge electroluminescence. In this way, it is generally utilized in wellbeing signs, crisis signals, and steady colors as a significant energy-saving and climate cordial material[9].With the advancement of long-radiance glowing materials, an ever increasing number of

scientists utilize long-luminosity materials as shades to get ready iridescent coatings[10].Luminescent coatings are made by blending brilliant shades, film-shaping materials, and added substances in extent, and they can adjust to various parkway conditions with iridescent sign and cautioning function[11].

Wentong Wang et.al, (2021)

"Concrete loaded up with bright materials for asphalt: Luminosity rot system and properties"[12]In other review, Self-glowing concrete based composite materials (SLCCM) are utilized in development and building material to decrease power utilization, works on driver's perceivability in evening and furthermore work on the wellbeing of street traffic. The mechanical qualities of the SLCCM examples first and foremost increment and afterward decline with the expanding of LP (glowing powder) content. The effective conservative brightening time for SLCCM having higher beginning brilliance after illumination are 30 min, while the lighting 60 min can reach 96.67% of the most extreme starting splendor, and the ideal LP content territory is 20-25%[13]. Ideal discharge range is yellowish go-ahead in the reach between 450 and 650 nm with a pinnacle worth of 514nm. SLCCM example with 20% LP focus @ 28 days will give the most noteworthy compressive strength.[14]

Muhammad Naeem et.al (2022)

"Use of Strontium Aluminate Europium and Dysprosium Doped in Concrete Mortar as a Radiant Material for the Support of Green Environments"[15]SAEDD implies strontium aluminate europium and dyprosium doping. Investigation of SAEDDs investigated the production and components of a brilliant sealant, which sparkled in obscurity (GITD), and could be applied to a substantial surface. Investigation of SAEDDs investigated the production and components of an iridescent sealant, which gleamed in obscurity (GITD), and could be applied to a substantial surfacecSrAlO4 powder well affected compressive properties of the mortar.[16] Long glimmer phosphorous could be utilized in imaging stockpiling, arising lighting and complex optical memory applications. Sand material, stones, or earth particles that changed from 0.02 to 2 mm were applied.[17]

Wentong Wang et al.,(2020)

"Self Radiant composite based materials: properties and mechanism."[18]In other review, brilliant concrete based composite materials (LCCM) were ready by doping iridescent powder (LP) and intelligent powder (RP) into concrete based materials. Specialists proposed a method for creating brilliant composite materials by joining glowing materials with customary structure materials, and they have done primer investigations on their planning, execution, and application, for example, adding iridescent materials to solidify cement to change the microstructure of cement [19]. Self-iridescent concrete asphalt is another kind of utilitarian asphalt with wellbeing, magnificence, energy saving, which is planned by involving ecological intriguing earth glowing materials and concrete as crude materials.[20]. Reports in the writing have depicted the consolidation of little estimated particles of phosphors into concrete or polymers for asphalt materials.

S. Sundari et.al.,(2021)

Trial concentrate on Brilliant Concrete[21].In other review the different exemplifications of light discharging substantial piece and a technique for incorporating a light radiating substantial construction. The light emanating substantial organization contains light producing pigments.[22]. In this review a test technique was created to measure the greatness and length of the luminance of the covered substantial surface; measuring the luminance was key in assessing the presentation of the radiant sealant.[23]. The sparkle in obscurity substantial items show great mechanical strength (e.g., compressive strength) and slide obstruction. The expansion of glowing strontium aluminate gives luminance that perseveres to as long as 10 hours to the substantial items.

Bei He et.al, (2019)

"Characteristics examination of self radiant concrete based composite materials with self cleaning effect."[24] In other review, self-brilliant concrete based composite materials (SLCCM) were ready by doping iridescent powder and intelligent powder into concrete based materials, and afterward self-glowing and self-cleaning concrete based composite materials (SSCCM) were gotten by hydrophobic treatment on the outer layer of the SCCM, a short time later their mechanical properties, radiant properties, hydrophobicity and system were assessed. Specialists have proposed by consolidating brilliant materials with customary structure materials to foster some iridescent composite structure materials, and have done fundamental examinations on its readiness, execution and application.[25]. Super-hydrophobic materials has stirred increasingly more consideration of analysts, and has bit by bit became one of the top subjects of ongoing years' exploring for practical material and self-cleaning technology.[26]

Ali Arabzadeh et.al,(2020)

("Superhydrophobic coatings on Portland concrete cement surfaces."[27] In othe study was to blend, describe and assess the nanomaterials-based superhydrophobic (super water-repellent) coatings on Portland concrete cement (PCC) surfaces. These coatings are combined with nanomaterials like polytetrafluoroethylene (PTFE), polyether ether ketone (Look) and silanized diatomaceous earth. Hydrophobicity is represented by compound properties of the materials - or surface energy - and a nano to miniature size various leveled geographical or surface harshness structure[28]. Superhydrophobic PCC, which can likewise be ice phobic , has been created by either applying siloxane-put together coatings or emulsions with respect to concrete with either a coordinated miniature surface or on concrete with inserted progressive structure.

3. MATERIALS AND PREPARATION

3.1 Yingli Gao et.al, (2017)

"Concentrate on properties and instruments of brilliant concrete based asphalt materials with super-hydrophobic capability." [1]The materials utilized for the planning of radiant concrete - based asphalt materials White Portland concrete; Iridescent powder (LP): uncommon earth glowing powder. Its principal

parts are SrAl2O4: Eu2+, Dy3+. The glimmer time apparent to the natural eye is more than the base splendor of 0.32 disc/m2 up to 8 h, detail for 600 cross sections; Intelligent powder (RP): likewise called phosphors, dark intelligent powder delivered by The vitally compound sythesis is SiO2. Determination for 200 cross sections; Water diminishing specialist: High effective naphthalene water lessening specialist, which is earthy colored yellow powder. Hydrophobic materials: Hydrophobic Fluoro silanes, dry straightforward Fluid. Ethanol: monetarily accessible modern insightful unadulterated.

a b c

Fig -1: a Cement, b Luminescent powder, c Reflective powder

Planning and blend plan: SLCPM examples were ready by utilizing the independent molds (50 mm ,50 mm,20 mm) radiance test and contact point test. The water concrete proportion of the examples is 0.35, and the concrete was similarly supplanted by LP (15%, 25%, 35% and 45% of concrete all out mass) and RP (0, 10%, 20% of concrete all out mass), separately. Therefore, SLCPM examples were moved out and put in a ventilated spot sitting tight for drying. From that point onward, the hydrophobic materials arranged ahead of time were covered to the outer layer of the SLCPM by utilizing covering treatment innovation (Fake fire plating). The outer layer of the SLCPM ought to keep clean, and that implies no contamination prior to being covered, and the covering ought to be covered with plastic film to keep water and residue from being dirtied. The plastic film can be uncovered while the covering is dry.

a b c

Fig-2: a Water reducing agent, b Hydrophobic Fluoro silane, c Ethanol

No.	C/g	LP		RP		Water reducer/g	w/b
		Addition content/g	Addition rate/%	Addition content/g	Addition rate/%		
0	1500	0	0	0	0	1.2	0.35
A-1	1300	195	15	0	0	1.7	0.35
A-2	1200	300	25	0	0	2.1	0.35
A-3	1100	385	35	0	0	2.4	0.35
A-4	1100	495	45	0	0	2.7	0.35
B-1	1200	180	15	120	10	3.1	0.35
B-2	1100	165	15	220	20	2.3	0.35
C-1	1100	275	25	110	10	2.4	0.35
C-2	1000	250	25	200	20	2.7	0.35
D-1	1000	350	35	100	10	2.7	0.35
D-2	1000	350	35	200	20	3.0	0.35

Table-1: Mix proportions of Luminescent cement mortar in the mechanical strength test (Yingli Gao et.al,(2017)

No.	C/g	LP		RP		w/b
		Addition content/g	Addition rate/%	Addition content/g	Addition rate/%	
1	300	45	15	0	0	0.35
2	270	67.5	25	0	0	0.35
3	258	90.3	35	0	0	0.35
4	240	108	45	0	0	0.35
5	258	64.5	25	25.8	10	0.35
6	240	60	25	48	20	0.35

Table-2: Mix proportion of luminescent mortar in the luminescence test(Yingli Gao et.al, (2017))

3.2 Bailin Shan et.al, (JAN 2022)

"Planning of High-Glow materials and use of Radiant coatings in street designing" [8]The objective of this study was to get ready long-glimmer iridescent coatings with high iridescence and fulfill the essential guideline prerequisites. The reagents and materials utilized for readiness of long-radiance brilliant coatings.

Preparation : Synthesis of SrAl2O4：Eu2, Dy3 Long-Afterglow Phosphors with High Luminescence

SrAl2O4：Eu2þ, Dy3þ materials were synthesized by the high temperature solid state reaction method. The ratio of raw materials was calculated according to the molar ratio of Sr1−x−yAl2O4：Eu2xþ, Dy3yþ, and 5% boric acid (H3BO3) was added as flux. Then, ammonium bicarbonate was added as a pore-forming agent. All raw materials were mixed thoroughly for 15 min in an agate mortar and pressed into tablets. The tablets were annealed at 1,300° C for 2 h in an active carbon atmosphere to prepare SrAl2O4：Eu2þ, Dy3þ phosphor with high luminous performance.By the single factor experiments the results indicated that the Luminescent prop were highest when flux content -> 5%, Calcination temperature -> 1300 ,Calcination time -> 2 h & ion doping ratio -> 1:1The amount of long afterglow materials has an important influence of the luminescent properties of the coating.The afterglow time of the coating increase gradually with the increase of the proportion of long afterglow phosphorous.The afterglow performance of coating was best when the proportion of long afterglow material was 40%The afterglow of luminous coatings could last for more than 7 hours in a dark environment after having irradiated by sunlight in the day time.

3.3 Wentong Wang et.al, (2021)

"Concrete loaded up with luminous materials for asphalt: Luminosity rot component and properties"[12] Natural substances: In this work, white Portland concrete was utilized and its fundamental specialized properties are recorded in Table 1. And furthermore glowing powder (LP) and reflected powder (RP) are utilized

Arrangement: Seven LP contents were planned as 15%, 20%, 25%, 30%, 35%, 40% and 45% of concrete mass. The RP contents were chosen in light of the finishes of past examination [23], wherein the ideal substance of RP was 10%. The blending water-concrete proportion stayed 0.4 for every example, faucet water was utilized here. [23] W. Jiang, P. Li, W. Ye, J. Shan, Y. Li, J. Xiao, The impact and system of La2O3 on the counter bright maturing attributes of virgin bitumen, Constr. Assemble. Mater. 230 (2020) 116967. The relieving conditions for SLCCM examples and PC were temperature 20 ± 2 degree C and relative dampness 93%.The 4 cm*4 cm*16 cm steel models and the 4 cm*4 cm*1 cm independent models were taken on to set up the examples.

3.4 Muhammad Naeem et.al (2022)

"Utilization of Strontium Aluminate Europium and Dysprosium Doped in Concrete Mortar as an Iridescent Material for the Support of Green Environments"[15] Materials: The mortar solid shapes were arranged utilizing different extents of phosphors. Generally speaking reason ordinary Portlantic concrete that followed Fortunate Concrete boundaries (Peshawar, Pakistan) was utilized to produce the example pieces. The concrete gravitational particulars, fineness, and molecule size (10-30 mm) continued as before. SrAlO4 at 10%, 20%, and 30% (by weight) was applied and the examples were named SAAS10, SASS10, SAAS20, SASS20, SAAS30, and SASS30. In the 3D square's arrangement, SiO2 particles of 125-250 μm were utilized. To fix the 3D square examples, 10% nitric corrosive (NHO3), hydrochloric corrosive (HCl), and sodium sulfate (Na2SO4) (Sigma Aldrich, Germany) were utilized.

3.5 Wengton Wang et al.,(September 2020)

"Self Glowing composite based materials: properties and system" [18] The impact of LP molecule size was the focal point of the review. Six molecule sizes of LP, with lattice of 40,80,150, 200, 400 and 600 which were separated into coarse powder. (40 and 80 cross section), medium measured (150 and 200 lattice) and fine powder (400 and 600 lattice), were utilized for setting up the LCCM examples. Three molecule sizes of RP (30, 100 and 200 lattice)

are taken on. The LCCM examples with various lattice of LPs were marked as LPM-40, LPM-80, LPM-150, LPM-200, LPM-400 and LPM - 600 and with RPs were named as RPM-30, RPM-100 and RPM-200.The powder contents are chosen in light of past exploration [27], where the ideal items in LP and RP are 25% and 10 %.The water concrete proportion was held as 0.35 continually. At the point when RP network stays steady, the compressive strength of LCCM test first increments and the decline with expanding LP network number at age of 3 and 28 days.

3.6 S. Sundari et.al.,(June 2021)

"Exploratory concentrate on Glowing Cement" [21] The iridescent cement can be ready by the accompanying three strategies. 1)Method of blending the glowing part 2) Technique for altering the microstructure of concrete. 3)Method of covering the surface with glowing mixtures. Out of these three strategies, the technique for blending the iridescent part and the strategy for covering the surface with radiant mixtures were embraced in this task. The iridescent substantial comprises of 1) Concrete 2)Coarse Total 3)Fine Total

4)Water5) Light radiating shades. Light radiating shades comprises of a titanium powder, a sulfide powder, and tars. Since iridescent cement can likewise be depicted as an extraordinary sort of cement in which extra property of luminance was prompted in the substantial by adding the light producing shades. Grade assignment - M 25 Information of materials gathered from tests: Explicit Gravity of concrete = 3.15 Explicit Gravity of fine total = 2.31 Explicit Gravity of Coarse total =2.96 Water concrete proportion = 0.48 Last Blend Proportion = 1: 1.63: 3.188; 0.48.Average compressive strength got at seventh day= 17.658 N/mm2. Normal compressive strength acquired at fourteenth day= 22.5 N/mm2. Normal compressive strength acquired at 28th day= 28.449 N/mm2.After saving the substantial block for 24 hours in sunshine, the substantial solid shape was seen to emanate the light for about almost nine hours. The rate expansion of the light transmitting shades must be expanded. All the more especially the expanded expansion of Strontium Aluminate will end in improved consequences of radiant cement.

No.	White cement/g	Luminescent powder		Reflective powder		Sand/g	Water reducer/g	Water/g	Water cement ratio
		Content/g	Ratio%	Content/g	Ratio%				
0	450	0	0	0	0	1350	0.45	198	0.44
1	450	337.5	25	0	0	1350	0.45	198	0.44
2	450			40.5	3	972	0.45	198	0.44
3	450			67.5	5	945	0.45	198	0.44
4	450			94.5	7	918	0.45	198	0.44
5	450	405	30	0	0	945	0.45	198	0.44
6	450			40.5	3	904.5	0.45	198	0.44
7	450			67.5	5	877.5	0.45	198	0.44
8	450			94.5	7	850.5	0.45	198	0.44
9	450	472.5	35	0	0	877.5	0.45	198	0.44
10	450			40.5	3	837	0.45	198	0.44
11	450			67.5	5	810	0.45	198	0.44
12	450			94.5	7	783	0.45	198	0.44

Table-9: Design of mix proportions of LCCM specimen[Bei He, Yingli Gao et, al(2019)]

3.7 Bei He, Yingli Gao et, al(2019)

"Characteristics examination of self glowing concrete based composite materials with self cleaning impact." [24] Materials: White Portland concrete, radiant powder (LP), Intelligent powder (RP), Fine total, very hydrophobic materials, ethanol, alkali deionized water. The fine total was similarly supplanted by the radiant powder (25%,30%,35%) and the intelligent powder was (0%,3%,5%,7%). The mechanical properties and radiant properties of SCCM could be improved by adding the brilliant powder and intelligent powder. The excitation range of the SCCM was situated at 430-700nm.Doping the brilliant powder into concrete based materials impacted the excitation of frequency and power in short band.The top frequency of emanation range was 520nm. What's more, the variety was yellowish green.

3.8 Ali Arabzadeh(2020)

"Superhydrophobic coatings on Portland concrete cement surfaces."[27]Materials: The chose plan factors incorporate the kinds of water - repellent materials (polytetra fluro ethylene (PTFE), polyether ketone (Look) and Silanized diatomaceous DE) and Splash length (4,6,8 and 10s).The Portland concrete substantial surfaces were covered with low surface energy materials.The examples covered with PTFE showed a similar pattern from 4 to 8 s, and that implies this sort of covering arrives at its best presentation at the splash term of 8s among the chose splash duration.The Silanized DE arrived at a fantastic super hydrophobicity with a deliberate of WCA 160° at the splash span of 10s.There cross over turf drag surface and cross over and longitudinal pronged surface are great possibility for upgrading the pallet obstruction of very hydrophobic unbending pavement.The slide safe covering made out of PTFE and Look was used to assess the effect of very hydrophobic covering on asphalt slide opposition.

4. RESULTS

The suitable expansion of LP can work on the mechanical strength of concrete based materials partially, while the expansion of RP meaningfully affects the strength of concrete based material. The increment of LP content can work on the radiant properties of SLCPM, and the examples can keep great glimmer in the wake of lighting 8 h; albeit the increment of the RP significantly affects working on the underlying splendor of SLCPM, it can further develop the luminosity execution and delay the phosphorescence season of SLCPM. The ideal substance of LP is 25% inside the dose rates chose for this review, generally the proclamation will excessively far reach. This ideal plan strategies for SLCPM, as better hydrophobicity is noticed if the superhydrophobic materials are covered to its surface as it were. The super-hydrophobic surface covering can keep up with great soundness and self-cleaning execution. The surface contact point and moving point can in any case reach 152.2 and 5.4, which can actually keep water and residue from dirtying and meet the super-hydrophobic prerequisites toward the finish of testing.The starting splendor of SLCPM expands first and afterward will in general be level with the increment of lighting time. Its speed and effectiveness of light excitation is higher. The SLCPM has more steady phosphorescence execution and higher recognizable proof.

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5. CONCLUSIONS

The increment of LP content can work on the iridescent properties of SLCPM, and the examples can keep great phosphorescence in the wake of lighting 8 h; albeit the increment of the RP affects working on the underlying splendor of SLCPM, it can further develop the luminosity execution and draw out the radiance season of SLCPM. The brilliant properties were most noteworthy when motion content, calcination temperature, calcination time, and interesting earth particle doping proportion were 5%, 1,300°C, 2h, and 1∶1, individually. The proper centralization of LP can work on the mechanical strength of SLCCM partially, though the expansion of LP with exorbitantly high satisfied antagonistically influences the strength of the SLCCM example, and the ideal LP content territory is 20-25 %. The suitable molecule size of LP and RP can work on the mechanical strength of concrete based radiant materials somewhat, while the expansion of LP with exorbitantly little or enormous particles antagonistically influences the strength of the LCCM example, and the ideal LP molecule size is 200 cross section. The excitation frequency scope of the LCCM was 350-450 nm. The pinnacle frequency of the outflow range was in the reach 510-520 nm, and the variety was yellowish green that will be apparent to the natural eye in dim. it was presumed that the doping the iridescent powder and intelligent powder could improve the splendor and radiance season of the SCCM example .

Authors including an appendix section should do so before References section. Multiple appendices should all have headings in the style used above. They will automatically be ordered A, B, C etc.

References

1. Gao, Yingli, et al. "Study on properties and mechanisms of luminescent cement-based pavement materials with super-hydrophobic function." Construction and Building Materials 165 (2018): 548-559.
2. Z. Xia, P. Du, L. Liao, G. Li, S. Jin, Synthesis and color-tunable luminescence properties of novel calcium aluminate silicate chloride phosphors, Curr. Appl. Phys. 10 (2010) 1087–1091.
3. N. Trivellin, M. Meneghini, M.D. Lago, D. Barbisan, M. Ferretti, G. Meneghesso, E. Zanoni, Characterization and endurance study of aluminate/silicate/garnet/ nitride phosphors for high-performance SSL, Proc. SPIE Int. Soc. Opt. Eng. 3 (2013) 8641–8654
4. G.B. Zhang, Z.M. Qi, H.J. Zhou, Y.B. Fu, T.L. Huo, X.X. Luo, C.S. Shi, Photoluminescence of (Eu2+Dy3+) co-doped silicate long lasting phosphor, J. Electron. Spectrosc. Relat. Phenom. 144–147 (2005) 861–863.
5. G. Tiwari, N. Brahme, R. Sharma, D.P. Bisen, S.K. Sao, S. Tigga, Luminescence properties of dysprosium doped di-calcium di-aluminium silicate phosphors, Opt. Mater. 58 (2016) 234–242.

6. P.W. Wilson, W. Lu, H. Xu, P. Kim, M.J. Kreder, J. Alvarengad, J. Aizenberg, Inhibition of ice nucleation by slippery liquid-infused porous surfaces (SLIPS), Phys. Chem. Chem. Phys. 15 (2) (2012) 581–585.
7. S.M. Rao, The Effectiveness of Silane and Siloxane Treatments on the Superhydrophobicity and Icephobicity of Concrete Surfaces, The University of Wisconsin, Milwaukee, 2013.
8. Shan, Bailin, et al. "Preparation of High-Luminescent Materials and Application of Luminescent Coatings in Road Engineering." Journal of Materials in Civil Engineering 34.8 (2022): 04022159.
9. Hu, X. W., H. Yang, T. T. Guo, D. H. Shu, W. F. Shan, G. Z. Li, and D. C. Guo. 2018. “Preparation and properties of Eu and Dy co-doped strontium aluminate long afterglow nanomaterials.” Ceram. Int. 44 (7): 755.
10. Bi, Y., J. Pei, Z. Chen, L. Zhang, R. Li, and D. Hu. 2021. “Preparation and characterization of luminescent road-marking paint.” Int. J. Pavement Res. Technol. 14 (2): 252–258
11. Liu, T., B. T. Campbell, S. P. Burns, and J. P. Sullivan. 1997. “Temperatureand pressure-sensitive luminescent paints in aerodynamics.” Appl. Mech. Rev. 50 (4): 227–246.
12. Wang, Wentong, et al. "Cement filled with phosphorescent materials for pavement: Afterglow decay mechanism and properties." Construction and Building Materials 284 (2021): 122798.
13. W.J. van der Merwe Steyn, Development of Autoluminescent Surfacings for Concrete Pavements, Transportation Research Record: Journal of the Transportation Research Board 2070(1) (2008) 22-31.
14. T. Longcore, C.J.F.i.E. Rich, t. Environment, Ecological light pollution, 2(4) [26] (2004) 191-198.
15. Naeem, Muhammad, et al. "Application of Strontium Aluminate Europium and Dysprosium Doped in Cement Mortar as a Luminescent Material for the Maintenance of Green Environments." Journal of Hazardous, Toxic, and Radioactive Waste 27.1 (2023): 04022032.
16. Maldiney, T., G. Sraiki, B. Viana, D. Gourier, C. Richard, D. Scherman, M. Bessodes, K. Van den Eeckhout, D. Poelman, and P. F. Smet. 2012. “In vivo optical imaging with rare earth doped Ca2Si5N8 persistent luminescence nanoparticles.” Opt. Mater. Express 2 (3): 261–268.
17. Nakamura, T., K. Kaiya, N. Takahashi, T. Matsuzawa, C. C. Rowlands, V. Beltran-Lopez, G. M. Smith, and P. C. Riedi. 2000. “High frequency EPR of europium (II)-doped strontium aluminate phosphors.” J. Mater. Chem. 10 (11): 2566–2569.
18. Wentong Wang et al.,(September 2020) “Self Luminous composite based materials: properties and mechanism.”
19. B.He,Y.Gao,L.Qu,K.Duan,W.Zhou,G.Pei,Characteristicsanalysisofselfluminescent cement-based composite materials with self-cleaning effect, J. CleanerProd.(2019)
20. resistantSiO2coatedSrAl2O4:Eu2+Dy3+persistentluminescencephosphor onthepropertieM.A. Sikandar, W. Ahmad, M.H. Khan, F. Ali, M. Waseem, Effect of water sofPortlandcementpastes,Constr.Build.Mater.228(2019).
21. S. Sundari et.al.,(June 2021), Experimental study on Luminescent Concrete.
22. Hadi Barghlame, Hojjat Hashempour Gavgani published a journal on Light Emitting Concrete Composition and Method of Synthesizing Light Emitting Concrete Structure, Publication of US20170029696A1.
23. Saleem, Muhammad, Blaisi, Nawaf Isam Ahmed, Luminescent concrete composition and product, Imam Abdulrahman Bin Faisal University.
24. Bei He, Yingli Gao*, Liangchen Qu, Kairui Duan, Wenjuan Zhou, Ganpeng Pei “Characteristics analysis of self luminescent cement based composite materials with self cleaning effect.”
25. Yang et al., 2009; Aich et al., 2013; Hu et al., 2017; Ebrahimzade et al., 2016). Zhou et al., 2015; Dominiak-Dzik and Ryba-Romanowski, 2008; De Pablos-Martin et al., 2017; Chen et al., 2015).
26. Nascimento et al., 2012; Muzenski et al., 2015; Arabzadeh et al., 2016.
27. Ali Arabzadeh, “Superhydrophobic coatings on Portland cement concrete surfaces.”
28. M. Horgnies, J.J. Chen, Superhydrophobic concrete surfaces with integrated microtexture, Cem. Concr. Compos. 52 (2014) 81–90, http://dx.doi.org/ 10.1016/j.cemconcomp.2014.05.010.
29. I. Flores-Vivian, V. Hejazi, M.I. Kozhukhova, M. Nosonovsky, K. Sobolev, Selfassembling particle-siloxane coatings for superhydrophobic concrete, ACS Appl. Mater. Interfaces 5 (2013) 13284–13294, http://dx.doi.org/10.1021/ am404272v.