RESEARCH PAPER

Latent fingerprints development using nanopowder (titanium dioxide)

Ritik Kushwah*

*Assistant Professor, Forensic science department, Renaissance University, Indore

ABSTRACT

This study was conducted for development of fingerprints that are invisible to the naked eye using nanopowder of titanium dioxide. The powder technique is very efficient over non porous surfaces and there are a wide variety of latent fingerprint development powders of different size, color andwith different fluorescence. The powder method involves the application of fine particles over the latent fingerprint by dusting method using camel or squirrel hair-brush. The powder cling to the ridges and remains unadhered to the valley portion and the powder being colorful is clearly visible to the eye that makes the latent print visible. This study is based on developing latent fingerprints with forenscope and with nanopowder of titanium dioxide. Slides containing latent fingerprint were first examined under forenscope and then were developed using titanium dioxide nanopowder by dusting method and then seen under trasoscan. This procedure went through 50 days. For analysis the ridge characteristics were taken as parameters for visibility of the developed prints. The result showed that both methods were useful in developing latent images upto fifty days and in both Forenscope has proven more convenient and gave better results.

Based on the study it could be concluded that nanopowder of titanium dioxide is useful in developing latent fingerprint over glass surface and the forenscope has some advantages over powder development method as it do not destroy the print while developing them.

Keywords: latent fingerprint; nanopowder; titanium dioxide; forenscope; trasoscan

How to cite this article: Kushwah R. Latent fingerprints development using nanopowder (titanium dioxide). Int J Drug Deliv Technol. 2026;16(15s): 276-282. DOI: 10.25258/ijddt.16.15s.35;

INTRODUCTION

The court or Criminal justice system relies on forensic science. Forensic scientists have a role to study as well as analyse the evidence from scene of crime and other locations in order to produce objective results that can aid in the investigation and in prosecution of criminals, or saving an innocent person (Henry C. Lee, 2001).

There are 7 principles of forensic science. They are:

1. Law of Individuality
2. Progressive change law.
3. Principle of Comparison.
4. Law of Analysis
5. Locard's mutual Exchange principle.
6. Law of Probability
7. Law of circumstantial facts.

Nanoparticles

According to the ISO technical specifications 80004 the nanoparticles are defined as an particles that have their 3 external dimension in the nanoscale, where both the longest and the shortest axes of particles don't differ much. Nanoparticles are particles of size ranging from 1-100 nanometer in diameter. Being very much smaller compared to the wavelengths of visible radiation (400-700nm), the nanoparticles cannnot be seen usingordinary microscopes that's why it necessitates the employment of electron-microscopes or microscopes that come with lasers (Chae, Kyu, Lee, Kim, Kim, & Lee, 2003). Nanoparticles have property that is often different than bigger particles of the same exact substance. As known already a diameter of an atom rest between 0.15 to 0.6nm. In the last 20 years, various types of nanoparticles are used in forensic science and for its numerous applications such as nanoparticles of Ag and Au as metal nanoparticles, somemetal oxides also used as fingerprint powder such as titanium dioxide, ZnO, iron oxide,and cadmium sulfide,conjugated polyelectrolyte dots (CPEDs), any many other are all been used as fingerprint powder.

Titanium dioxide powder: -

Dioxide of titanium can also be called as titanium(IV) oxide. It is an inorganic powder with the chemical Formula TiO2. It is if used as pigment then known as titanium pigment, Pigment White 6 (PW6) (Volz, 2006). Titanium dioxide is a white coloured water-insoluble solid. Being a pigment it does have numerous applications such as in sunscreen, paint and also food coloring (Mineral Commodity Summaries, 2015). It is widely used as white pigment due to its high brightness and a very high refractive index and in this it is surpassed by only few other materials (Clair, 2016). It is also used for dielectric mirrors as an excellent reflective optical coating (Koleske, 1995).

MATERIALS AND METHODOLOGY

Sample collection: -

For collection of samples non-porous surface such as glass slides are used to collect latent fingerprints by the number of subjects. There are two sets of samples: set A and set B. Set A contains Right thumb fingerprint of a single subject and set B contains right thumb fingerprint of multiple subject taken at different interval of time and after different activities on the same day.For the collection of inked prints the same

*Author for Correspondence: Ritik Kushwah

subjects were taken and asked to give their thumb prints using an black ink pad.

Procedure: -

1. Glass slides were washed, cleaned, dried and then stored in packed boxes
2. The subject was asked to give their right thumb impression on the glass slides.
3. After taking the latent fingerprint they are immediately kept inside the box again.
4. While analysing each slide is taken one at a time.
5. Firstly, the slide is kept under forenscope and examined using U3A filter in under UV light.
6. When the prints were clearly visible, photographs were taken immediately through forenscope itself and stored.
7. Then the slide is taken for powder dusting.
8. Nanopowder of Titanium dioxide was dusted using camel hair brush and the prints were developed.
9. The developed print was then put under the trasoscan and seen under light ranging 365nm.
10. Again image was taken through trasoscan and stored.
11. Fingerprint using ink pad were also taken for reference on plain white sheet and 8Characteristics are marked on it.
12. Both the images from forenscope and Trasoscan were simultaneously analysed and compared with the inked prints and the observations were noted.

Sample analysis

Analysis of the two sets A&B each containing 50 slides bearing latent fingerprint has successfully done by comparing each fingerprint from the forenscope developed prints and trasoscan clicked images with the inked prints obtained from the subject.

Fingerprint of set A has been taken from a single subject whereas for set B fingerprints of 8 different subjects were taken on glass slides at different interval of time on the same day. Analysis was done by marking 8 Ridge characteristics on the reference inked prints and the same were compared with Trasoscan and forenscope developed images.

OBSERVATION TABLE

Forenscope Light source & Filter used= UV out with U3A filter.

S.No.	Day	Total minutiae	Minutiae no. found in Forenscope and its percentage		Minutiae no. found in trasoscan and its percentage		Score F	Score T
1	Day 1	8	8	100%	8	100%	4	4
2	Day 2	8	8	100%	8	100%	4	4
3	Day 3	8	8	100%	8	100%	4	4
4	Day 4	8	8	100%	8	100%	4	4
5	Day 5	8	8	100%	8	100%	4	4
6	Day 6	8	8	100%	8	100%	4	4
7	Day 7	8	7	87.5%	7	87.5%	3	3
8	Day 8	8	8	100%	7	87.5%	4	3
9	Day 9	8	7	87.5%	8	100%	3	4
10	Day 10	8	8	100%	7	87.5%	4	3
11	Day 11	8	7	87.5%	7	87.5%	3	3
12	Day 12	8	7	87.5%	7	87.5%	3	3
13	Day 13	8	8	100%	5	62.5%	4	2
14	Day 14	8	7	87.5%	7	87.5%	3	3
15	Day 15	8	7	87.5%	8	100%	3	4
16	Day 16	8	8	100%	7	87.5%	4	3
17	Day 17	8	8	100%	6	75%	4	3
18	Day 18	8	8	100%	6	75%	4	3
19	Day 19	8	7	87.5%	7	87.5%	3	3
20	Day 20	8	8	100%	7	87.5%	4	3
21	Day 21	8	8	100%	6	75%	4	3
22	Day 22	8	8	100%	7	87.5%	4	3
23	Day 23	8	7	87.5%	7	87.5%	3	3
24	Day 24	8	8	100%	7	87.5%	4	3
25	Day 25	8	8	100%	5	62.5%	4	2

S.No.	Day	Total minutiae	Minutiae no. found in Forenscope and its percentage		Minutiae no. found in trasoscan and its percentage		Score F	Score T
26	Day 26	8	8	100%	5	62.5%	4	2
27	Day 27	8	8	100%	6	75%	4	3
28	Day 28	8	8	100%	5	62.5%	4	2
29	Day 29	8	7	87.5%	6	75%	3	3
30	Day 30	8	7	87.5%	7	87.5%	3	3
31	Day 31	8	8	100%	7	87.5%	4	3
32	Day 32	8	8	100%	7	87.5%	4	3
33	Day 33	8	8	100%	6	75%	4	3
34	Day 34	8	8	100%	7	87.5%	4	3
35	Day 35	8	7	87.5%	6	75%	3	3
36	Day 36	8	8	100%	8	100%	4	4
37	Day 37	8	8	100%	6	75%	4	3
38	Day 38	8	8	100%	7	87.5%	4	3
39	Day 39	8	8	100%	8	100%	4	3
40	Day 40	8	8	100%	4	50%	4	2
41	Day 41	8	8	100%	7	87.5%	4	3
42	Day 42	8	8	100%	6	75%	4	3
43	Day 43	8	7	87.5%	7	87.5%	3	3
44	Day 44	8	7	87.5%	7	87.5%	3	3
45	Day 45	8	7	87.5%	8	100%	3	4
46	Day 46	8	8	100%	8	100%	4	4
47	Day 47	8	8	100%	8	100%	4	4
48	Day 48	8	7	87.5%	8	100%	3	4
49	Day 49	8	8	100%	8	100%	4	4
50	Day 50	8	8	100%	8	100%	4	4

Nanometer range used in Trasoscan = 365nm.

S.No.	Day	Total minutiae	Minutiae no. found in Forenscope and its percentage		Minutiae no. found in trasoscan and its percentage		Score F	Score T
1	Day 1	8	8	100%	8	100%	4	4
2	Day 2	8	8	100%	8	100%	4	4
3	Day 3	8	8	100%	8	100%	4	4
4	Day 4	8	7	87.5%	7	87.5%	3	3
5	Day 5	8	8	100%	8	100%	4	4
6	Day 6	8	8	100%	8	100%	4	4
7	Day 7	8	8	100%	7	87.5%	4	3
8	Day 8	8	8	100%	7	87.5%	4	3
9	Day 9	8	7	87.5%	7	87.5%	3	3
10	Day 10	8	8	100%	8	100%	4	4
11	Day 11	8	7	87.5%	7	87.5%	3	3
12	Day 12	8	8	100%	8	100%	4	4
13	Day 13	8	8	100%	8	100%	4	4
14	Day 14	8	8	100%	7	87.5%	4	3
15	Day 15	8	7	87.5%	7	87.5%	3	3
16	Day 16	8	8	100%	6	75%	4	3
17	Day 17	8	8	100%	7	87.5%	4	3
18	Day 18	8	8	100%	7	87.5%	4	3
19	Day 19	8	8	100%	8	100%	4	4
20	Day 20	8	7	87.5%	7	87.5%	3	3
21	Day 21	8	7	87.5%	7	87.5%	3	3
22	Day 22	8	7	87.5%	7	87.5%	3	3
23	Day 23	8	8	100%	8	100%	4	4
24	Day 24	8	8	100%	7	87.5%	4	3
25	Day 25	8	8	100%	8	100%	4	4

S.No.	Day	Total minutiae	Minutiae no. found in Forenscope and its percentage		Minutiae no. found in trasoscan and its percentage		Score F	Score T
26	Day 26	8	8	100%	8	100%	4	4
27	Day 27	8	8	100%	7	87.5%	4	3
28	Day 28	8	8	100%	7	75%	4	3
29	Day 29	8	8	100%	6	75%	4	3
30	Day 30	8	8	100%	8	100%	3	3
31	Day 31	8	7	87.5%	8	100%	3	4
32	Day 32	8	8	100%	7	87.5%	4	3
33	Day 33	8	8	100%	7	87.5%	4	3
34	Day 34	8	7	87.5%	6	75%	3	3
35	Day 35	8	8	100%	7	87.5%	4	3
36	Day 36	8	8	100%	7	87.5%	4	3
37	Day 37	8	7	87.5%	7	87.5%	3	3
38	Day 38	8	8	100%	8	100%	4	4
39	Day 39	8	8	100%	7	87.5%	4	3
40	Day 40	8	7	87.5%	7	87.5%	4	3
41	Day 41	8	8	100%	7	87.5%	4	3
42	Day 42	8	7	87.5%	7	87.5%	3	3
43	Day 43	8	8	100%	6	75%	4	3
44	Day 44	8	7	87.5%	7	87.5%	3	3
45	Day 45	8	8	100%	8	100%	4	4
46	Day 46	8	8	100%	7	87.5%	4	3
47	Day 47	8	7	87.5%	6	75%	3	3
48	Day 48	8	8	100%	7	87.5%	4	3
49	Day 49	8	8	100%	7	87.5%	4	3
50	Day 50	8	8	100%	7	87.5%	4	3

Table 1 : for set A

Table 2: for set B

RESULT

Zetasizer Data:

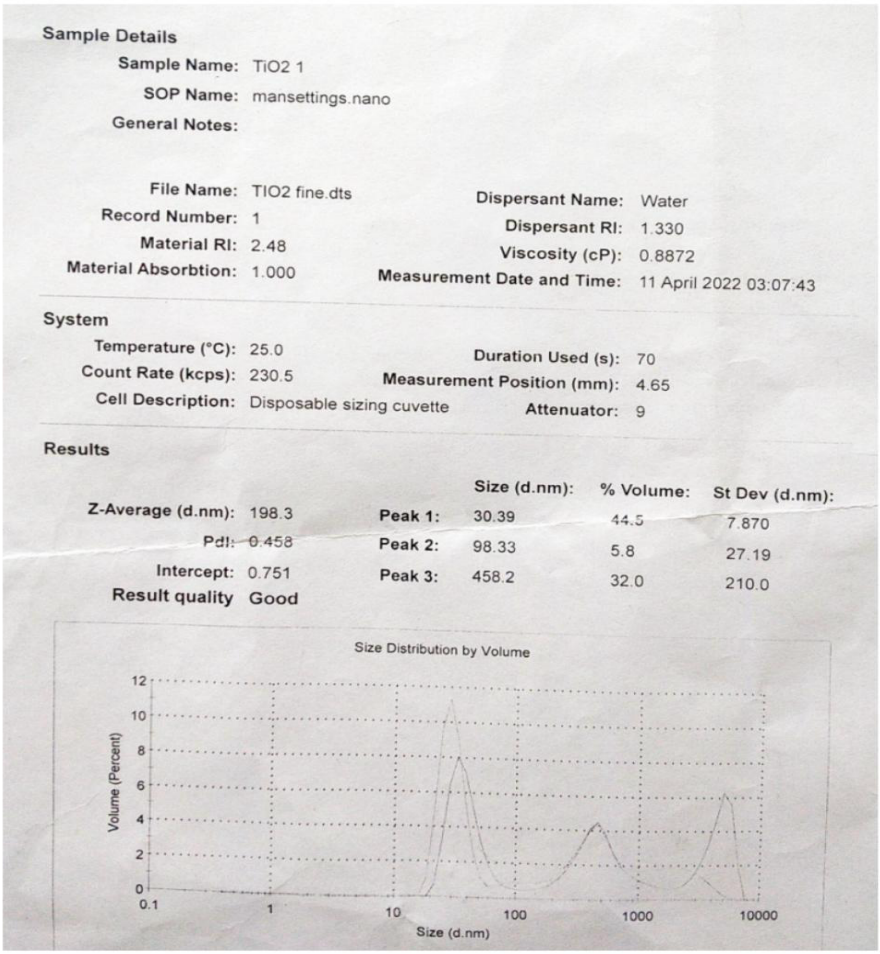

Fig 1: Mass distribution with graph of size distribution by volume

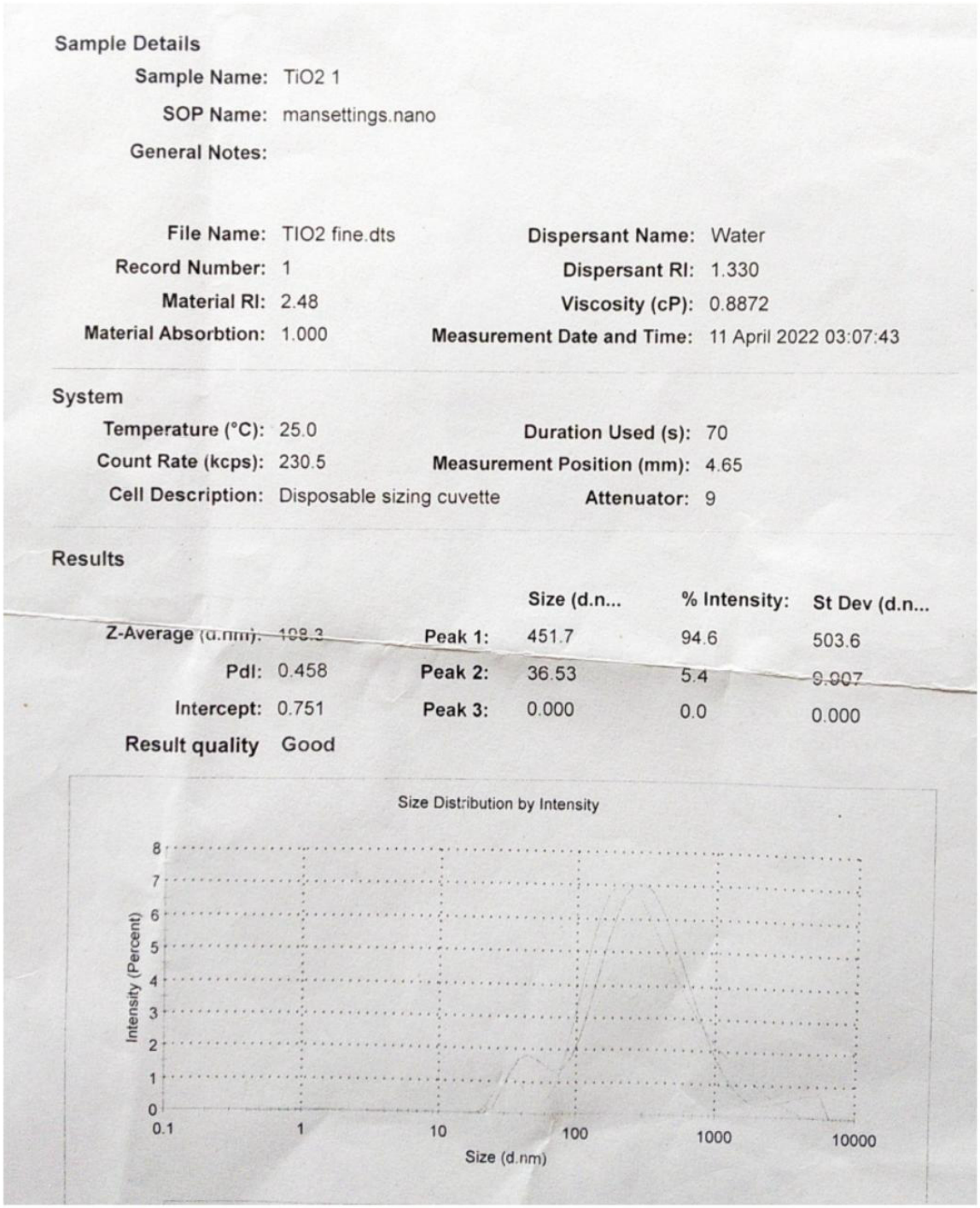

Fig 2: Intensity distribution result with graph of size distribution by intensity

DISCUSSION

In Zetasizer, for the sample the solvent or dispersant used was water and its refractive index was found to be 1.330. Viscosity (cP) was found to be 0.8872 and the obtained results of mass distribution in which the Zaverage (d.nm) value that is 198, which is the mean of three peaks (30.39, 98.33 and 458.2). This peaks shows the size of the particles in nanometers. The result also show that the PDI value is 0.458. The temperature was kept 25 degree celcius and the duration was about 70 seconds.A graph of size against Volume was plotted which was showing 3 peaks. The first was at 30.39, second at 98.33 and the last at 458.2 nm. A figure showed data of the reports'from zetasizer about intensity distribution performed on the sample of nanopowderof titanium dioxide. According to it the Z-Average (d.nm) value is 198.3 and sample run time was 70 seconds. The 3 peaks shows different values. They are 451.7, 36.53, and 0.000 d.nm. The intensity percentage were 94.6, 5.4, 0.00. The graph of size distribution by intensity was plotted and it shows 3 peaks that are the 3 particle sizes. The first peak showed size 451.7, second as 36.53, and third peak haven't shown because the values are in zeros. The

Table 1 A showed the data of Set-A fingerprints that were developed using forenscope and titanium dioxide powder. The data has drawn according to the number of ridge characteristics found on the prints out of 8 that are already defined on inked prints. The Table 2 B showed the data of Set-B fingerprints that were developed using forenscope and titanium dioxide powder. The data has drawn according to the number of ridge characteristics found on the prints out of 8 that are already defined on inked prints. From the Tables 1& 2 it is also found that there is high accuracy in results of forenscope as compared to powder developed images as the forenscope developed images showed good quality fingerprints with minimum damages.

CONCLUSION

The Nanoparticles of Titanium dioxide was synthesized using Ball milling machine operated at 400rpm for 10 hours and it was put into use with the acceptable size. The characterization was done using Zetasizer. The application of these powder is done in detection and development of latent fingerprint. From the observations it can be concluded that both forenscope and Titanium dioxide nanopowder were able to develop prints efficiently till 50 days and among both Forenscope has proven more efficient by giving better results than powder development method as the ridges in forenscope were continuous and almost completely visible but in powder developed prints some prints got smuged and some didn't showed adhesion with the powder, however the print developed from powder method are more clear to the naked eye after development.

FUTURE SCOPE:

Nanoparticles has a great scope in future. It saves reagent as well as time plus provides better results. Addition of proper binder and some fluorescent material to pure titanium oxide can help in better results and may result into development ofeven much older prints. Use of nanoparticles in the field of forensic science has started already and is also the future of it. Nanoparticles also helps in increasing the surface area thereby making powder more efficient. Addition of different fluorescent materials (organic or inorganic) can be of great help as it could be utilized in developing prints at any coloured surface just by adjusting the fluorescent material in the titanium oxide powder. Due to smaller particle size, the nanoparticles can show florescence at faster rate and at low nanometer range. Thereby making titanium oxide nanopowder more useful because of its property to get nanostructured by simple methods.

LIMITATIONS

In every scientific study there are some limitations and in this study the limitations comes in the dusting technique as dusting of powder may slightly disturb the prints or can even result in destruction of the latent prints. Pure titanium dioxide do not show much adhesion to the latent fingerprints therefore requiring some binders. And also it is only useful over dark non porous surfaces only. Dusting method for titanium dioxide is not effective on wet surfaces, it requires particle suspension method. Nanopowder requires good quality dusting brush as the particle size is so small that it may not stick to some ordinary brush.

REFERENCE

1. Lynch, C. A. (2005). The history of grinding.
2. Sharma, A., & R. S. (2014). Synthesis of titanium dioxide nanoparticles by sol–gel method and their characterization. Journal of Basic and Applied Engineering Research, 1.
3. Amin, M. O., & M. M.-H. (2018). Metal oxide nanoparticles for latent fingerprint visualization and analysis of small drug molecules using surface-assisted laser desorption/ionization mass spectrometry. Analytical and Bioanalytical Chemistry, 410, 4815–4827.
4. Arslan, B., & S. S. (2019). Fingerprint forensics in crime scene: A computer science approach. Journal of Information Security Science, 88–112.
5. Chae, S. Y., Kyu, M., Lee, S. K., Kim, T. Y., Kim, S. K., & Lee, W. (2003). Preparation of size-controlled titanium dioxide nanoparticles and derivation of optically transparent photocatalytic films. Chemistry of Materials, 15, 3326–3331.
6. Choi, M. J., & M. A. (2008). Metal-containing nanoparticles and nanostructured particles in fingerprint detection. Forensic Science International, 179, 87–97.
7. Choi, M. J., & S. T. (2007). Fluorescent titanium dioxide powders prepared using a perylenediimide dye. Forensic Science International.
8. Clair, K. S. (2016). The secret lives of colour. John Murray.
9. Wade, D. C. (2002). Development of latent fingerprints with titanium dioxide. Journal of Forensic Identification, 52, 551–559.
10. Hawthorne, M. R. (2009). Fingerprint analysis and understanding. Taylor & Francis.
11. Lee, H. C. (Ed.). (2001). Advances in fingerprint technology (2nd ed.).
12. Lee, H. C., & Gaensslen, R. E. (2001). Advancement in fingerprint technology (2nd ed.). CRC Press.
13. Hinners, P. L. (2020). Revealing chemical evidence from fingerprints through matrix-assisted laser desorption/ionization mass spectrometry imaging.
14. Kanbar, A. B. (2016). Fingerprint identification for forensic crime scene investigation. International Journal of Computer Science and Mobile Computing, 5(8), 60–65.
15. Koleske, J. V. (1995). Paint and coating testing manual. ASTM International.
16. Sametband, M., & S. I. (2007). Application of nanoparticles for the enhancement of latent fingerprints. Chemical Communications, (11).
17. U.S. Geological Survey. (2015). Mineral commodity summaries.

18. Salah, N., S. S.-H., et al. (2011). High energy ball milling technique for ZnO particles as antibacterial material. International Journal of Nanomedicine, 863–869.
19. Cuce, P., & F. G. (2004). Small particle reagents technique can help to print out wet latent fingerprints. Forensic Science International, 146S, S7–S8.
20. Hinners, P., & J. Y. (2020). Mass spectrometry imaging of latent fingerprints using titanium oxide development powder as an existing matrix. Journal of Mass Spectrometry, 55(10).
21. Prabakaran, E., & P. K. (2021). Nanomaterials for latent fingerprint detection. Journal of Materials Research and Technology, 12, 1856–1885.
22. Reynolds, A. J., & J. B. (2008). Nanoscale analysis of titanium dioxide fingerprint development powders. Journal of Physics: Conference Series, 126.
23. Sanders, D. G. (1996). Notes on some latent fingerprint visualization techniques.
24. Batista, C. S., Larson, R. G., & Kotov, N. A. (2015). Nonadditivity of nanoparticle interactions. Science.
25. Takacs, L. (2002). Self-sustaining reactions induced by ball milling. Progress in Materials Science, 47(4), 355–414.
26. Tang, H. W., & L. W. (2010). Gold nanoparticles and imaging mass spectrometry: Double imaging of latent fingerprints. Analytical Chemistry, 1589–1593.
27. Tran, T., & W.-J. C.-S. (2003). Preparation of titanium dioxide nanoparticles in glycerol-containing solution.
28. Volz, H. G. (2006). Pigments, inorganic. In Ullmann's encyclopedia of industrial chemistry.
29. Chen, Y. F., & C. M. (2003). The effect of calcination temperature on the crystallinity of titanium dioxide nanopowder. Journal of Crystal Growth, 247, 363–370.