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Antibacterial Activity of Zno Thin Films Prepared By Sol-Gel Dip-Coating Method

G. Parthasarathy[1], Dr. M. Saroja[2], Dr. M. Venkatachalam[2], P. Gowthaman[3], Sounder. J[4]
[1,4]Ph.D Research Scholar, [2]Associate Professor, [3]Assistant Professor, Thin film Research Centre, Erode Arts and Science College, Erode

***Abstract:** The ZnO thin films are used in the field of pharmaceutical sciences and it has more number of applications which plays an important role on antibacterial activity. In modern era, the ZnO thin films pepared by biological and chemical methods using microorganisms, enzymes, and plant extracts has been suggested as ecofriendly to environment. The potential toxicity of ZnO thin films were investigated using both Gram positive and Gram negative bacteria as test organisms. The results showed that ZnO thin film nanoparticles enhanced the good antibacterial activity.*

I. INTRODUCTION

In the last few years, the research is more carried out on energy conservation and green technologies. This research involves the eco-friendly semiconductor metal oxide such as TiO_2, ZnO, SnO_2 etc., [1, 2]. ZnO can be used either in the form of a thinfilm or as a powder. Here the challenging application of ZnO thin films is to make better the self-cleaning properties of window glass. ZnO can be coated onto glass and retain their antibacterial and photocatalytic properties. The antibacterial property makes it desirable in hospital, Pharmaceutical and food industries where there is need for hygienic situation [4,5]. In this, the ZnO thin films were prepared by sol-gel dip-coating method. The antibacterial activity was determined by testing the inhibit growth of S.typhi, S.aureus, B.subtilis, E.coli and P.aeruginosa bacteria.

II. MATERIALS AND METHODS

The sol of 0.5M concentration was prepared by dissolving the required amount of Zinc acetate dehydrate [Zn $(CH_3\ COO_2).2H_2O$] into 20ml of iso-propanol which contains monoethanolamine (MEA) acting as a stabilizer. The molar ratio of Zn^{2+} to MEA is kept as 1:1 throughout the synthesis. Then homogeneous solution was stirred at 70^0C for 1hr to accelerate hydrolysis reaction to obtain a transparent sol-gel, which is used for coating after cooled to room temperature and also aged for 24hrs.

ZnO thin films are prepared by depositing sol on the glass substrate by using dip-coating method, that time duration as 30sec of dip and 1 minute dry at 75^0C and this is repeated for 10 times. Then subsequently coated films are calcinated by annealing at 400^0C for 1hr to achieve the pure ZnO thin films. Finally the ZnO thin films are allowed to cool to room temperature and further it has taken for various studies.

A. Antimicrobial Assay

Inoculums are prepared by, that the stock cultures are stored at 4^0C on slope of nutrient agar. Active cultures of experiment was prepared by shifting a loopful of cells from the stock cultures to the test tube of Muller-Hinton broth(MHB), that are incubated without agitation for 24 hours at 37^0C and 25^0C. Then the cultures are diluted with the fresh Muller-Hinton broth to gain optical densities approximately to 2.0 x 10^6 CFU/ ml for bacteria.

Here the disc diffusion method (Bauer *et al.*, 1966) was used to screen the antibacterial activity. In *vitro*, the microbial activity has been screened by using Muller-Hinton Agar (MHA) from Hi-media, Mumbai. The MHA plates are prepared using 15 ml of molten media into sterile petri plates. The plates are dried for 5 minutes and 0.1 %, inoculums suspension was swabbed throughout the plate and dried for 5 minutes. The concentration of extracts is 4 mg/disc was loaded on 6 mm sterile disc. The loaded disc was placed on the surface of the medium and extract was allowed to diffuse for 5 minutes and the plates are kept in incubator for 24 hours at 37^0C. As a result, the incubation zones on the disc were measured with the help of transparent ruler. The inhibition zones are obtained in the range of millimeter.

III. RESULT AND DISCUSSION

A. Antibacterial Activity

The antibacterial activity of ZnO thin film shows better effect against P.aeruginosa, S.typhi, S.aureus, E.coli and B.subtilis shown in Figure 1. The maximum zone of inhibition obtained for 50µl concentration was observed that P.aeruginosa (26mm), S.typhi (23mm), S.aureus (19mm), E.coli (18m) and B.subtilis (16mm) shown in Table 1.

Table 1: Antibacterial activity of ZnO thin film

S.NO.	Organisms	Gram	Zone Of Inhibition (mm)				
			Control	Concentration of Sample 20µl	Concentration of Sample 30µl	Concentration of Sample 40µl	Concentration of Sample 50µl
1	P.aeruginosa	-ve	24 mm	12 mm	16 mm	19 mm	26 mm
2	S.typhi	-ve	19 mm	10 mm	15 mm	18 mm	23 mm
3	S.aureus	+ve	22 mm	11 mm	13 mm	16 mm	19 mm
4	E.coli	-ve	20 mm	12 mm	13 mm	15 mm	18 mm
5	B.subtilis	+ve	21 mm	9 mm	12 mm	14 mm	16 mm

P.aeruginosa is a gram-negative bacterium, which causes serious illnesses – hospital acquired infections such as ventilator associated pneumonia and various sepsis syndromes. Hence the prepared ZnO thin film has shown the highest inhibition zone against this bacterium.

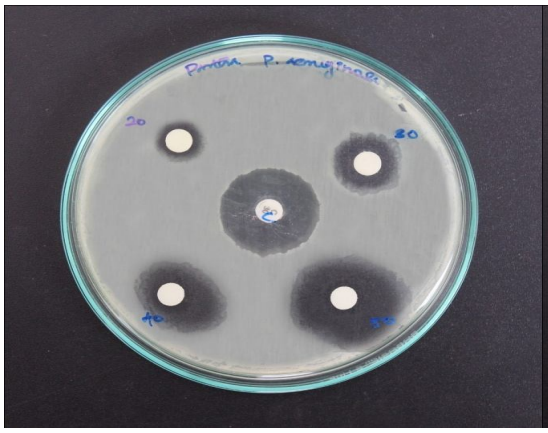

Figure 1(a)

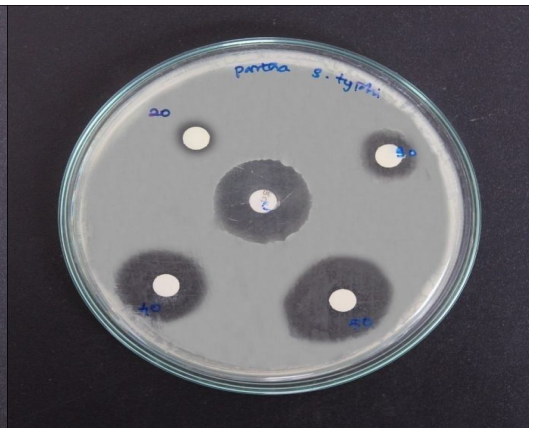

Figure 1(b)

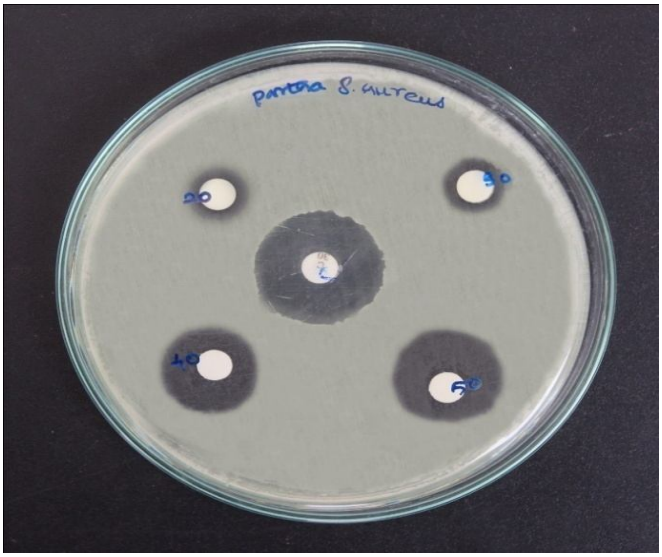

Figure 1(c)

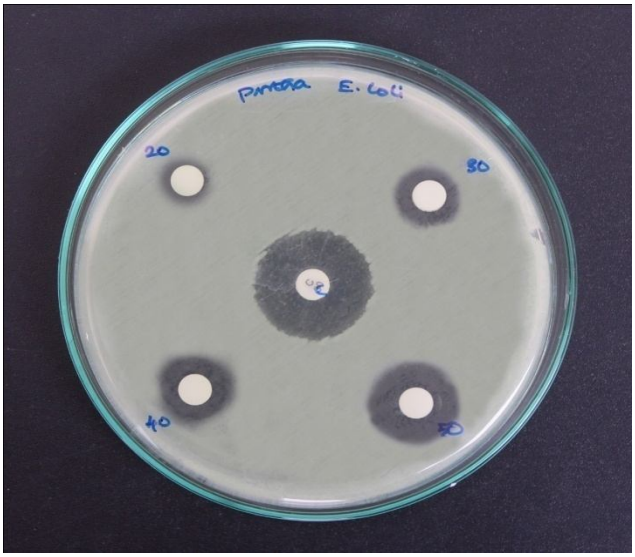

Figure 1(d)

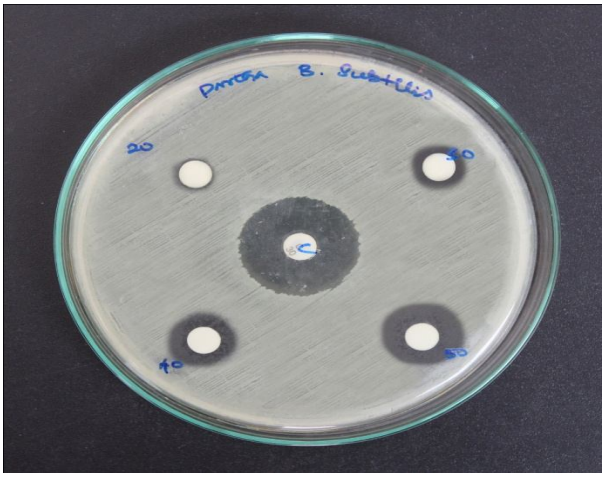

Figure 1(e)
Figure 1: Antibacterial activity of ZnO thin film against multiple pathogens

B. X-Ray Diffraction

By scattering the X-ray beam on the sample, we get the information about the crystallographic structure, chemical and physical properties of the ZnO nanoparticles. The 2θ values 32.04, 34.97, 36.52, 47.81, 56.90, 62.64, 68.39, and 69.27 is corresponding to the plane of (100), (002), (101), (102), (110), (103), (112) and (201) respectively according to JCPDS No. 036 1451 shown in Figure 2. The particle sizes are obtained in the range of 13.86, 9.25 and 18.38 nm. The nanoparticle sizes are calculated by using Debye Scherrer's formula.

$$D = \frac{K\lambda}{\beta \cos \theta} Å$$

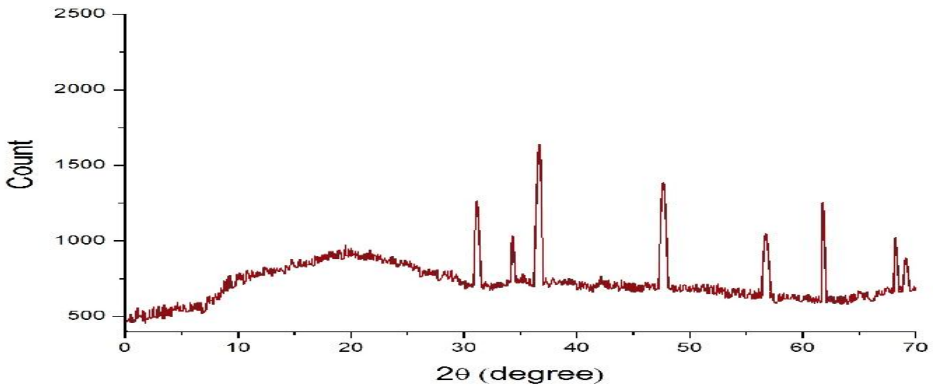

Figure 2: XRD pattern of ZnO thin film

C. SEM Imaging

This analysis was performed by using Hitachi S-4500 Scanning Electron Microscope. SEM image Figure 3 shows that the ZnO nanoparticles are in amorphous form.

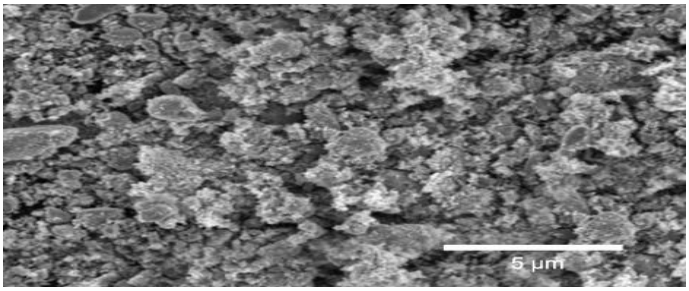

Figure 3: SEM image of ZnO thin film

IV. CONCLUSION

A ZnO thin film prepared from the 0.5M Zn^{2+} concentration produced a highest surface area that enhanced bacterial killing activities. The ZnO thin film has varied applications in all fields. Of special mention is the antimicrobial activity of ZnO thin film. The enhanced bioactivity of ZnO thin film is attributed to the higher surface area to volume ratio. Therefore, based on the reported antibacterial activity, it can be concluded that the ZnO thin film constitute an effective antimicrobial agent against pathogenic microorganisms. Further the illumination of ZnO thin films by UV light can also generate reactive species as superoxide radicals or hydroxyl radical in an aqueous environment and it is used to degrade organic dyes and bacterial cell walls.

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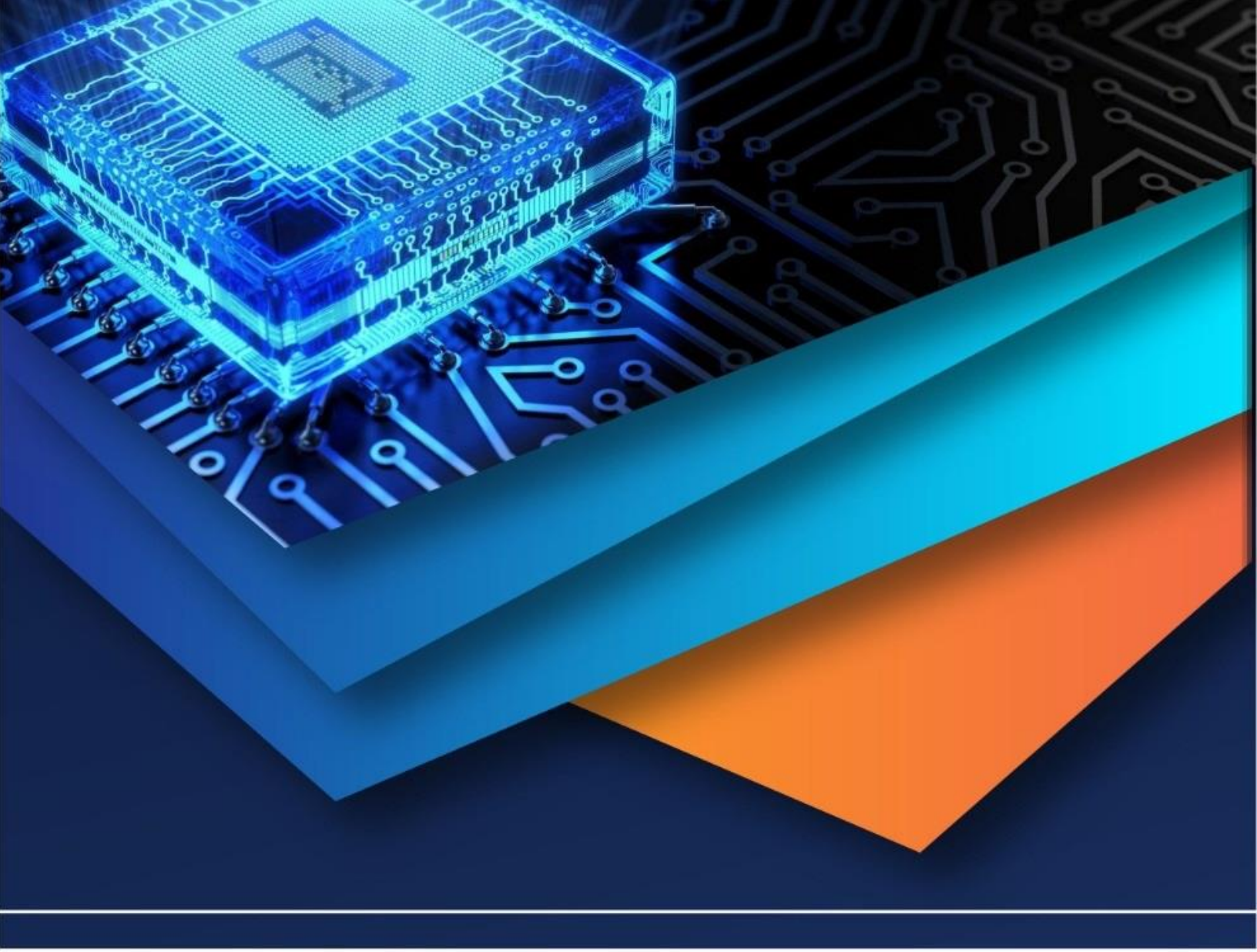
A. Conflict of Interest

There are no conflicts of interest.

B. Financial support and sponsorship Nil

REFERENCES

[1] Fujishima, T.N. Rao, D.A. Tryk, Titanium dioxide photocatalysis, J.Photochem. Photobiol. C: Photochem. Rev. 1 (2000) 1–21.
[2] K. Rajeshwar, M.E. Osugi, W. Chanmanee, C.R. Chenthamarakshan, M.V.B.Zanoni, P.Kajitvichyanukul, R. Krishnan-Ayer, Heterogeneous photocatalytic treatment of organic dyes in air and aqueous media, J. Photochem. Photobiol.C: Photochem. Rev. 9 (2008) 171–192.
[3] K.R. Murali, Preparation of sol–gel dip-coated zinc oxide thin films, J. Phys.Chem. Solids 98 (2007) 2293–2296.
[4] K.A. Whitehead, N L. Caballero.S. Allen, J. Verran, Inactivation of Escherichia coli on immobilized TiO2 using fluorescent light, J. Photochem. Photobiol. A: Chem.202 (2009) 92–98.
[5] J. Zhao, X. Yang, Photocatalytic oxidation for indoor air purification: a literature review, Build. Environ. 38 (2003) 645–654.
[6] G. Srinivasan, N. Gopalakrishnan, Y.S. Yu, R. Kesavamoorthy, J. Kumar, Influence of post-deposition annealing on the structural and optical properties of ZnO thin films prepared by sol–gel and spin-coating method, Superlattices Microstrut. 43 (2008) 112–119.
[7] D. Wang, G.P. Bierwagen, Sol–gel coating on metals for corrosion protection,Prog. Org. Coat. 64 (2009) 327–338.
[8] P. Jongnavakit, P. Amornpitoksuk, S. Suwanboon, T. Ratana, Surface andphotocatalytic properties of ZnO thin film prepared by sol–gel method, Thin Solid Films 520 (2012) 5561–5567.
[9] J. Lv, W. Gong, K. Huang, J. Zhu, F. Meng, X. Song, Z. Sun, Effect of annealing temperature on photocatalytic activity of ZnO thin films prepared by sol–gel method, Superlattices Microstruc. 50 (2011) 98–106.
[10] M. Dutta, S. Mridha, D. Basak, Effect of sol concentration on the properties ofZnO thin films prepared by sol–gel technique, Appl. Surf. Sci. 254 (2008) 2743–2747.
[11] M.T. Weller, Inorganic Materials, Oxford Chemistry Primer, 1996. p. 15.
[12] R.D. Gonzalez, T. Lopez, R. Gomez, Sol–gel preparation of supported metalcatalysts, Catal. Today 35 (1997) 293–317.
[13] C.J. Brinker, A.J. Hurd, P.R. Schunk, G.C. Frye, C.S. Ashley, Review of sol–gel thin film formation, J. Non-Crystal. Solids 147–148 (1992) 424–436.
[14] T. Koehler, S. Gledhill, A. Grimm, N. Allsop, C. Camus, A. Hänsel, W. Bohne, J.Rohrich, M. Lux-Steiner, C.H. Fischer, An investigation of the dip-Ion layer gas reaction process to produce ZnO films with increased deposition rates, Thin Solid Films 517 (2009) 3332–3339.
[15] J. Lv, K. Huang, X. Chen, J. Zhu, C. Cao, X. Song, Z. Sun, Optical constants of Na doped ZnO thin films by sol–gel method, Opt. Commun. 284 (2011) 2905–2908.
[16] L. Zhang, Y. Ding, M. Povey, D. York, ZnO nanofluids–a potential antibacterial agent, Prog. Natl. Sci. 18 (2008) 939–944.
[17] L. Jing, X. Sun, J. Shang, W. Cai, Z. Xu, Y. Du, H. Fu, Review of surface photovoltage spectra of nano-sized semiconductor and its applications in heterogeneous photocatalysis, Solar Energy Mater. Solar Cells 79 (2003) 133–151.
[18] H. Wang, C. Xie, W. Zhang, S. Cai, Z. Yang, Y. Gui, Comparison of dye degradation efficiency using ZnO powders with various size scales, J. Hazard.Mater. 141 (2007) 645–652.
[19] K. Haga, M. Kamidaira, Y. Kashiwaba, T. Sekiguchi, H. Watanabe, ZnO thin films prepared by remote plasma-enhanced CVD method, J. Cry. Growth 214–215(2000) 77–78.
[20] V. Tvarozek, I. Novotny, P. Sutta, S. Flickyngerova, K. Schtereva, E. Vavrinsky, Influence of sputtering parameters on crystalline structure of ZnO thin films, Thin Solid Films 515 (2007) 8756–8760.



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