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Short Communication

Comparison of TiO_2 nanoparticles impact with TiO_2/CNTs nano hybrid on microbial community of staphylococcus

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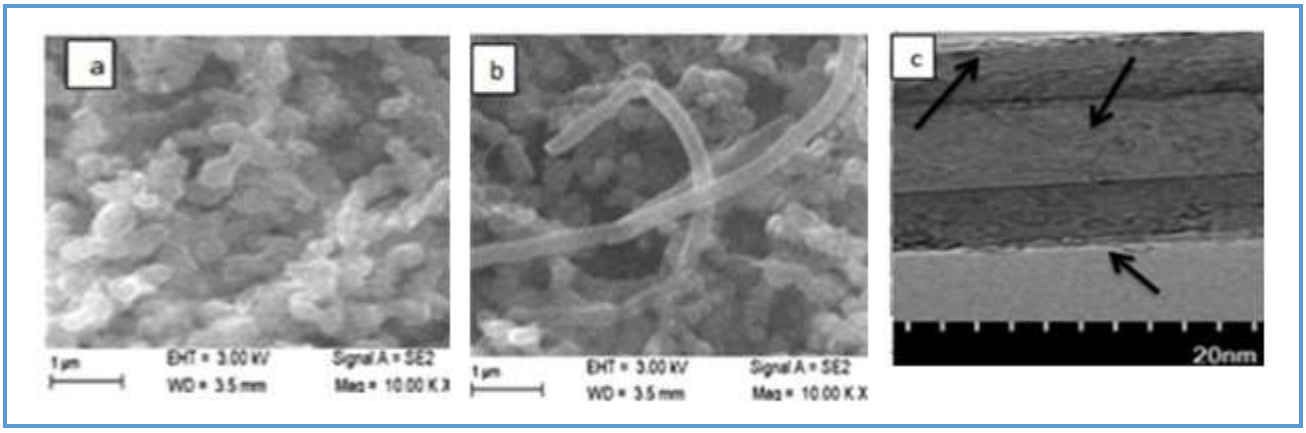
ABSTRACT

There has been an increase in carbon nanotubes (CNT) uses in different industries; however, its impact on the environment is still under a vast consideration and investigation. In this research study, the soil with staphylococcus has been exposed to pure TiO_2 and TiO_2/CNT. Also, the community of the staphylococcus was studied using the scanning electron microscopy (SEM). It has been observed that, the microbial community has decreased tremendously after the titanium oxide was doped with CNT. This study suggests that, the TiO_2/CNTs can be a much more effective potential material for altering the microbial community compared with the TiO_2. These findings could be useful for creating antibacterial agents for the soil using TiO_2/CNTs nano hubrid .Further investigation of the TiO_2/CNTs mechanism could prove useful for industrial uses or altering microbial communities.

Graphical Abstract



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Introduction

Staphylococci are gram-positive bacteria with a diameter ranging from 0.5 µm to 1.5 µm that has been found in the form of grape-like clusters [1]. These types of bacteria can be found in environments such as soil, water, and the human body [2]. Recently there have been numerous cases of bacterial resistance and health organizations investigating the spread of the antibiotic resistance bacteria [3]. Since nanotechnology can be used in various fields, it is a fortune to apply this science for antibacterial applications. Antibacterial activity is defined as substances that have the capability to kill the bacteria or slow down their growth [4]. One of the reasons that nano particles can be used as antibacterial substances is that they have a high surface area to volume ratio, giving them superior properties. In this study, the antibacterial substances which were used are carbon nanotubes and TiO_2/CNT. CNTs have been proven to be an anti-bacterial agent [5]. CNTs have been also used to modify the microbial community of microorganisms in the soil [6, 7]. TiO_2 has also been reported to have an effect on Microbial Communities in Stream Sediment [8, 9]. However, to our knowledge, there has not been a report on comparison of these two substances investigating their impact on soil staphylococcus. So in this paper pure TiO_2 and TiO_2/CNTs have been compared in order to investigate their effect on staphylococcus community in the soil.

Experimental

Materials and Methods

Pure CNTs were prepared using the technique described in our previous study [10]. Titanium dioxide (99.9%) was purchased from Sigma Aldrich. To synthesize the TiO_2/CNTs, 1 mL of nitric acid was added to the aqueous solution of CNT and after addition of 1g of TiO_2, the sample was sonicated. The samples were sonicated for 40 min and then dried at 40 °C. The soil was innoculated with uniform amount of staphylococcus and then it was exposed to 20 mg of TiO_2 and TiO_2/CNTs. The results were compared by visual analytical method of SEM**.**

Results and Discussion

Figure 1**a** and **b** show the raman spectra of the pure CNTs and TiO_2/CNTs specimens. As can be seen, the graphite-like carbon materials exhibited peaks at 1580 cm^{-1}, 1350 cm^{-1}, 2650 cm^{-1}, and 2930 cm^{-1} cor-responding to the G band, D band, G' band, and the G + D band (or G"), respectively [11]. The TiO_2 peaks was observed at 147, 395, 513, and 650 cm^{-1} [12]. Figure 1**c** exhibits the characteristic peaks of the CNT and TiO_2, showing that the TiO_2 was doped with CNTs [13].

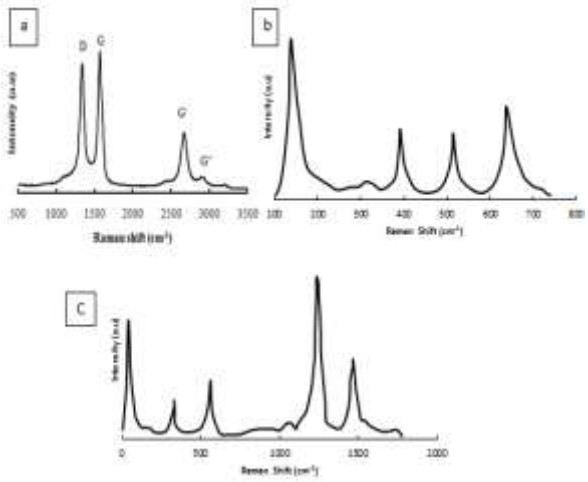

Figure 1. a) Raman spectra of pure CNTs, b) raman spectra of TiO_2, c) raman spectra of TiO_2/CNTs

Figure 2**a** depicts the SEM images of the titanium oxide. As can be seen, the TiO_2 have a spherical shape. Figure 2**b** shows the titanium oxide after pontificated with CNTs. To make sure that CNTs are doped with titanium oxide,

the close up TEM image of the CNTs were taken, as can be seen in Figure 2**c**, some titanium oxides are functionalized on the walls of the CNTs (shown with arrows).

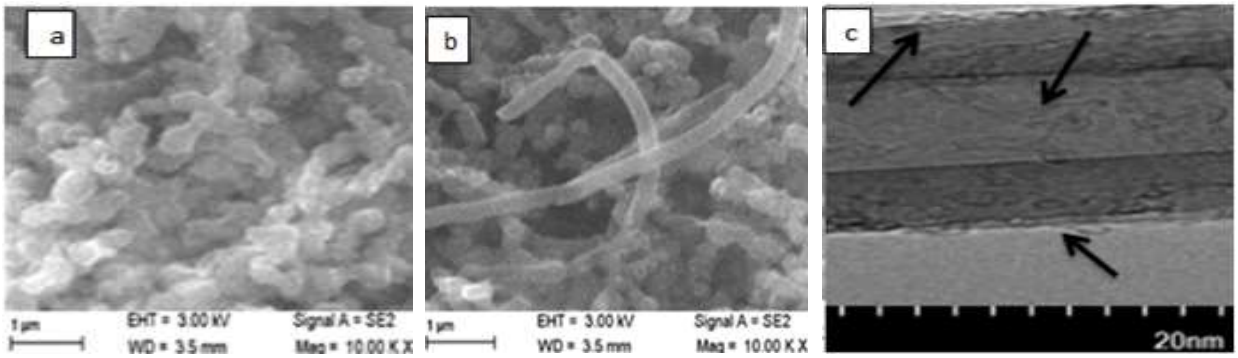

Figure 2. a) SEM micrographs of TiO_2, b) TiO_2/CNTs, c) TEM image of the TiO_2 in the walls and tubes of CNTs

Figure 3**a** shows the sample of staphylococcus with no TiO_2 and TiO_2/CNTs. Staphyls dishes were treated with 20 mg of TiO_2 in one dish and TiO_2/CNTs in another dish. SEM has been taken after 3 weeks. Figure 3**b** shows the results for the sample treated with TiO_2, and Figure 3**c** shows the sample treated with TiO_2/CNTs. The results showed that using TiO_2/CNT were more effective in decreasing the total counts of the staphylococcus compared with the TiO_2. This fact showed the role of CNTs in modifying the population of the bacterial community compared with that of the TiO_2 alone.

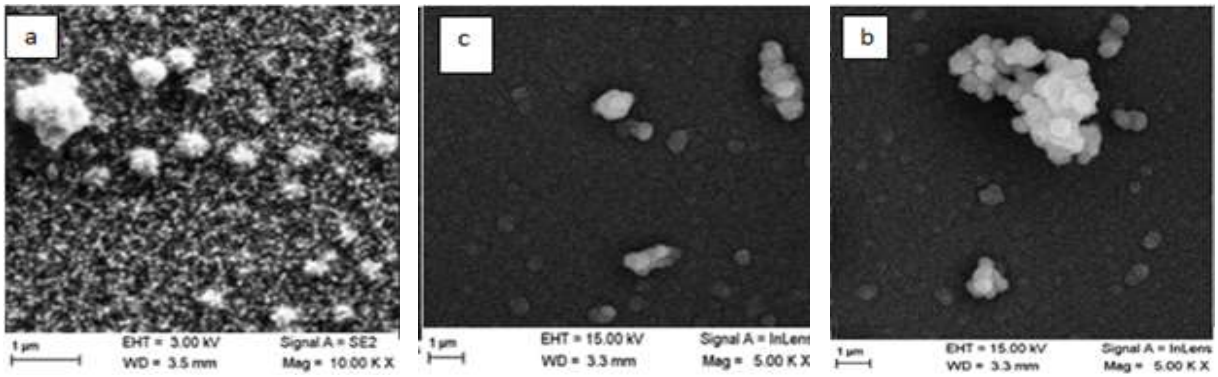

Figure 3. a) SEM micrographs of Staphylococcus, b) result of the microbial community exposed to TiO_2, c) result of the microbial community exposed to TiO_2/CNTs

Conclusion

This study investigated the effect of CNTs addition on TiO_2 as antibacterial substance. Comparing the performance of the sample treated with TiO_2 with TiO_2/CNTs revealed that CNTs showed an important and effective role in altering the microbial community of the staphylococcus. TiO_2/CNTs treated soil had less counts of staphylococcus than TiO_2 treated soil. This result can be used for investigating the TiO_2/CNTs mechanism of interaction with microbial community and their application for soil and industry; however, it is reccomeneded

to further study the toxicity of the TiO_2/CNTs in the soil environment.

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Disclosure statement

No potential conflict of interest was reported by the authors.

References

[1]. Harris L.G., Foster S.J., Richards R.G. *Eur Cell Mater* , 2002, **4:**1

[2]. Roszak D.B., Colwell R.R. *Microbiological Reviews*, 1987, **51**:365

[3]. Chudobova D., Dostalova S., Blazkova I., Michalek P., Ruttkay-Nedecky B., Sklenar M., Nejdl L. *International journal of environmental research and public health* , 2014, **11**:3233

[4]. Von Nussbaum F., Brands M., Hinzen B., Weigand S., Häbich D. *Angewandte Chemie International Edition*, 2006, **45**:5072

[5]. Kang S, Pinault M., Pfefferle D.L., Elimelech M. *Langmuir*, 2007, **23**:8670

[6]. Tong Z., Bischoff M., Nies F.L., Myer P., Applegate B., Turco F.R. *Environmental science & technology*, 2012, **46**:13471

[7]. Chung H., Son Y., Yoon T.K., Kim S., Kim W. *Ecotoxicology and Environmental Safety*, 2011, **74**:569

[8]. Ozaki A. Assessing the Effects of Titanium Dioxide Nanoparticles on Microbial Communities in Stream Sediment Using Artificial Streams and High Throughput Screening. 2013

[9]. Tsuang Y.H., Sun J.S., Huang Y.C., Lu C.H., Chang W.H.S., Wang C.C. *Artificial Organs*, 2008, **32**:167

[10]. Allaedini G., Aminayi P., Tasirin S.M. *Chemical Engineering Research and Design,* 2016, **112**:163

[11]. Romero L., Binions R. *Langmuir* , 2013, **29**:13542

[12]. Hardcastle F.D. *Journal of the Arkansas Academy of Science*, 2011, **65**:43

[13]. Sadeghian S., Khanlari M.R. *International Journal of Applied Physics and Mathematics*, 2014, **4**:363

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