

# Electrochemical sensor based on TiO<sub>2</sub> nanoparticles obtained with *Aloe vera* for the determination of dithiophosphates in mineral processing and environmental samples

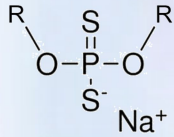
Javier Ernesto Vilasó Cadre<sup>1</sup>, Alondra Ramírez Rodríguez<sup>1</sup>, Juan Hidalgo<sup>2</sup>, Iván A. Reyes Domínguez<sup>1</sup>, Roel Cruz<sup>1</sup>, Graziella L. Turdean<sup>2</sup>

<sup>1</sup> Institute of Metallurgy, Autonomous University of San Luis Potosí, Mexico.

<sup>2</sup> Faculty of Chemistry and Chemical Engineering, "Babes-Bolyai" University, Romania.



## Introduction



They have been applied as lubricants, extractant reagents, and mainly as collectors in mineral flotation.

The toxicity of dithiophosphates may be greater than that of other organophosphorus compounds. In humans, they have been linked to immune damage.

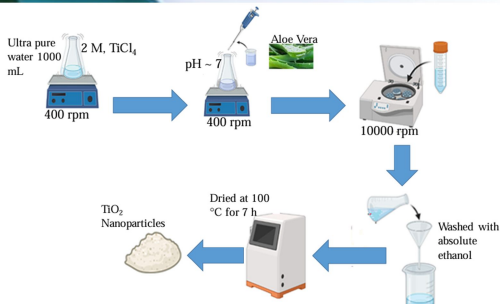
Therefore, the control of dithiophosphates in the mining industry and in the ecosystems where this activity takes place is essential.

In this work, TiO<sub>2</sub> spherical nanoparticles were synthesized using the reductive method with *Aloe vera* extract and they were applied as a modifier for a voltammetric sensor for dithiophosphates.

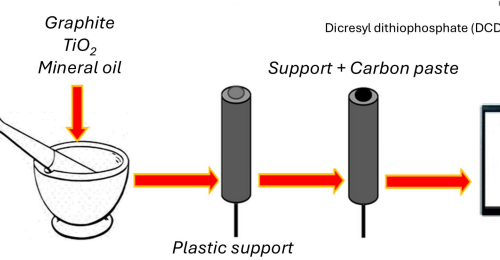
## Organic dithiophosphate

## Methodology

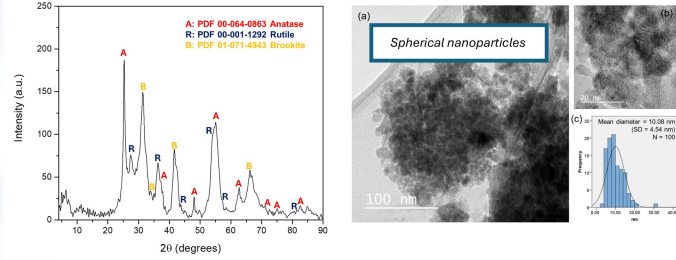
### Nanoparticle synthesis



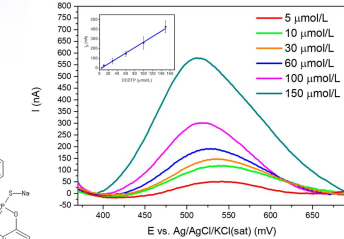
### Preparation of carbon paste electrode



### Nanoparticles characterization

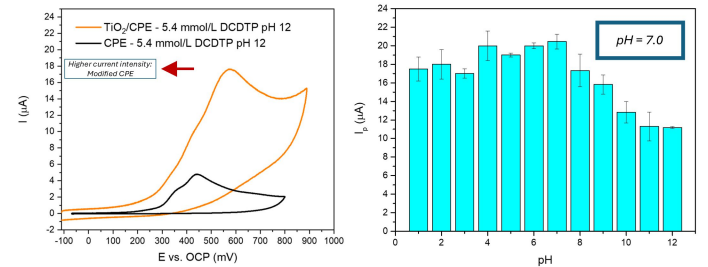


### Calibration

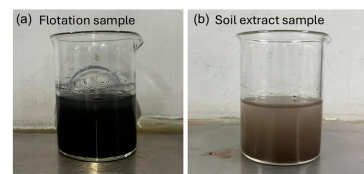


## Results

### Electrochemical response



### Real samples



### Real samples analysis

Experiment	DCDTP (mmol/L)	
	UV	Voltammetry
1	4.48	5.12
2	4.48	4.35
3	4.46	4.13
4	4.93	4.91
5	5.15	4.67
Mean	4.74	4.63
SD	0.29	0.41
t-statistic = 0.50 p-value = 0.6440		

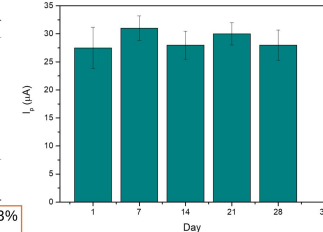
Experiment	DCDTP (mmol/L)	
	UV	Voltammetry
1	2.99	2.51
2	3.15	1.61
3	2.82	1.46
4	2.79	3.19
5	2.80	2.47
Mean	2.91	2.25
SD	0.16	0.71
t-statistic = 1.86 p-value = 0.1362		

### Repeatability test

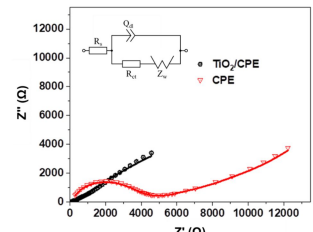
Experiment	I <sub>p</sub> (nA)	DCDTP (mmol/L)
1	276	0.095
2	310	0.107
3	281	0.097
4	304	0.105
5	278	0.096
6	279	0.096
7	306	0.105
8	279	0.096
9	331	0.114
10	296	0.102
Mean		0.101
SD		0.006
RSD (%)		6.08

AOAC: for the 10 - 100 ppm concentration range, RSD 7.3% - 5.3%  
For DCDTP: c = 33.57 ppm

### Reproducibility test



### EIS



## Conclusions:

TiO<sub>2</sub> nanoparticles obtained with *Aloe vera* extract allow voltammetric quantification of dithiophosphates in industrial and environmental samples with sensitivity, low detection limit, repeatability and reproducibility. The resistance to charge transfer is lower in the nanoparticle-modified sensor than in the unmodified carbon paste electrode.