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## Environmental Science Nano

PAPER

## **Electronic Supplementary Information**

## Real-time and selective detection of nitrates in water using graphene-based fieldeffect transistor sensors

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**Fig. S1** (a) FTIR spectra of rGO, TEBAC, and rGO/TEBAC. The vertical lines represent the characteristic peaks: red lines for rGO, green lines for TEBAC. (b) Standard infrared spectrum of benzyl tri-ethyl ammonium chloride (TEBAC). The standard spectrum was obtained from the National Institute of Advanced Industrial Science and Technology (AIST) (http://sdbs.db.aist.go.jp). The TEBAC infrared spectrum in our study is consistent with the standard spectrum.

**Table S1** FTIR characteristic band positions (cm<sup>-1</sup>) of rGO, TEBAC and rGO/TEBAC and their corresponding chemical groups.

rGO						1727.6		1564.2	
TEBAC	3469.3	3378.7	3231.6	2994.2	2983.6		1613.6		1484.4
rGO/TEBAC	3469.3	3378.7	3231.6	2994.2	2983.6	1727.6	1613.6	1564.2	1484.4
chemical group	-OH	-OH	Ar-H	-CH <sub>2</sub> -	-CH <sub>3</sub>	C=O	benzene	benzene	benzene
	(free)	(bond)					skeleton	skeleton	skeleton
rGO			1215.6						
TEBAC	1395.0	1377.1		1159.9	1085.7	1009.2	922.1	753.1	
rGO/TEBAC	1395.0	1377.1	1215.6	1159.9	1085.7	1009.2	922.1	753.1	
chemical group	-CH <sub>3</sub>	-CH₃	C-O-C	C-N	C-N	Ar-H	Ar-H	Ar-H	



**Fig. S2** Dynamic responses of two typical rGO/TEBAC sensors exposed to nitrate solutions with a concentration from 0.0028 to 28 mg/L NO3-N. Both sensors show rapid current decreases to nitrate ions of various concentrations.



**Fig. S3** Dynamic responses of blank device to aqueous solutions containing nitrates from 0.0028 to 28 mg/L. The current shows fluctuations when the nitrate solutions were added and no permanent current change was found. The control experiment results show that the nitrate ions have a negligible contribution to the blank electrodes, and the current change of the rGO/TEBAC sensor to nitrates is coming from the conductivity change of the rGO channel.



**Fig. S4** Dynamic responses of the sensors to nitrate solutions (0.3 and 3 mg/L) of different pH (pH = 5-9, a-e) and (f) their sensitivity comparisons. The results show that the sensors have significant responses to nitrates in the tested pH range.

	Methods	LOD (M)	Detection time	
Conventional	Ultraviolet (UV) spectroscopy <sup>1, 2</sup>	2.2×10 <sup>-6</sup>	Minutes	
Techniques	UV resonance Raman spectra <sup>3</sup>	1.4×10 <sup>-6</sup>	10 min	
	Microwave spectra <sup>4</sup>	4.8×10 <sup>-4</sup> (30 mg/L)		
	Gas chromatography-Mass spectrometer <sup>5</sup>	1×10 <sup>-6</sup>	~ 9.4 min	
	Ion chromatography <sup>6</sup>	9.7×10 <sup>-8</sup> (6 ppb)	30 s	
	High-performance liquid chromatography <sup>7</sup>	2×10 <sup>-8</sup>	8 min	
Electronic	Ion-selective electrode (potentiometric sensor) <sup>8</sup>	1×10 <sup>-6</sup>	25 s	
Sensors	Nanocopper-based electrode (electrochemical sensor) <sup>9</sup>	1×10 <sup>-7</sup>	Seconds	
	NaR-organic FET sensor <sup>10</sup>	7.3×10 <sup>-7</sup>	< 20 s	
	rGO/TEBAC FET sensor (this work)	7.86×10 <sup>-8</sup>	2-7 s	

**Table S2** Performance comparison of different methods for detecting  $NO_3^{-1}$  in water.

## Notes and references

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