

# Magnetic and Conductive Magnetite Nanowires by DNA-templating

*Hasan D. A. Mohamed, Scott M. D. Watson, Benjamin R. Horrocks, Andrew Houlton\**

Chemical Nanoscience Laboratory, School of Chemistry, Newcastle University, Newcastle-  
Upon-Tyne, NE1 7RU (UK)

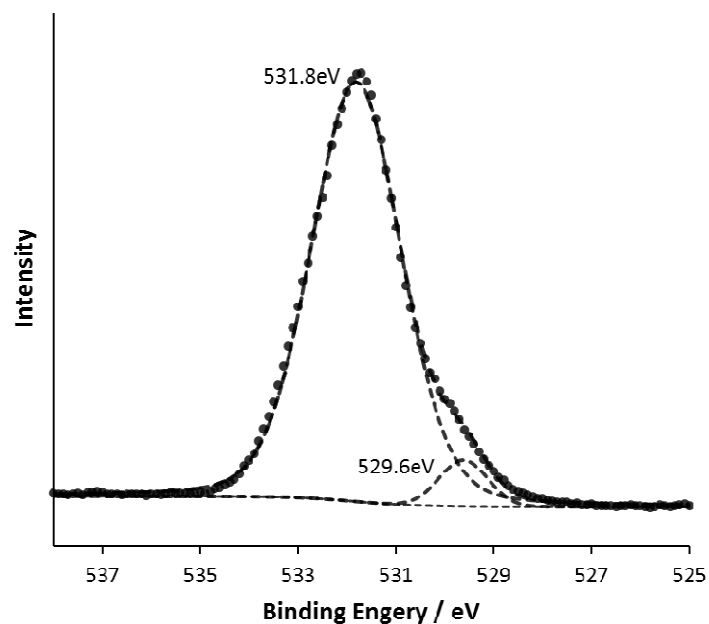
**Supporting Information**

**Table S1.** Assignment and comparison in FTIR spectra (500–4000 $\text{cm}^{-1}$ ) of bare calf thymus DNA, and calf thymus DNA-templated with  $\text{Fe}_3\text{O}_4$ .

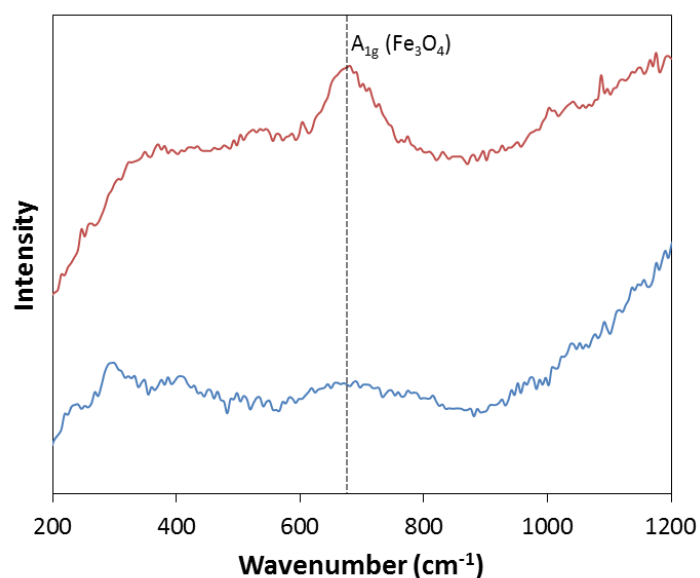
DNA	Wavenumber ( $\text{cm}^{-1}$ )	Assignment <sup>a</sup>	DNA/ $\text{Fe}_3\text{O}_4$	Wavenumber ( $\text{cm}^{-1}$ )	Assignment <sup>a</sup>
-	-	-		562	Fe-O stretch
960		C-C deoxyribose stretch		964	C-C deoxyribose stretch
1033 <sup>b</sup>		C-O deoxyribose stretch		1006 <sup>b</sup>	C-C deoxyribose stretch
1071		C-O deoxyribose stretch		1065	C-O deoxyribose stretch
1097		$\text{PO}_2^-$ symmetric stretch		1081	$\text{PO}_2^-$ symmetric stretch
1246		$\text{PO}_2^-$ asymmetric stretch		1212	$\text{PO}_2^-$ asymmetric stretch
1368		C-N stretch of cytosine and guanine		1336	C-N stretch of cytosine and guanine
1416		C-H, N-H deformation; C-N stretch		-	-
1488		Ring vibration of cytosine/guanine		1472	Ring vibration of cytosine/guanine
1529		In-plane vibration of guanine and cytosine		-	-
1603 <sup>b</sup>		In-plane vibration of adenine		1581 <sup>b</sup>	In-plane vibration of adenine
1653		C=O stretch of cytosine/thymine; In-plane vibration of thymine		1643	C=O stretch of cytosine/thymine; In-plane vibration of thymine
1692		C=O stretch of guanine/thymine; N-H thymine		-	-
2850–3750		C-H stretches; N-H stretches, O-H stretches		2850–3500	C-H stretches; O-H stretches; N-H stretches

<sup>a</sup> Assignments of DNA vibration bands reference to [1–7].

<sup>b</sup> Peak appeared as a shoulder.

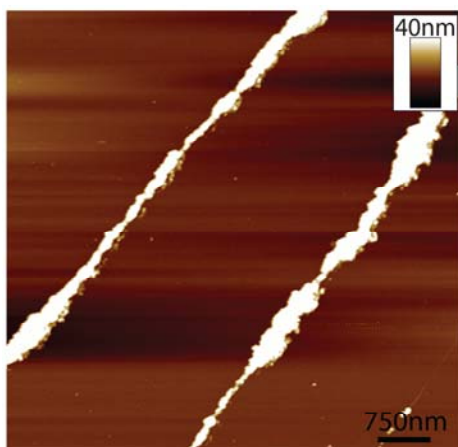


**Fig. S1** High resolution XPS spectrum of O1s region of calf thymus DNA-templated Fe<sub>3</sub>O<sub>4</sub> nanowires immobilised upon a Si/native SiO<sub>2</sub> substrate. Curve fitting of the region shows that at least two distinct peaks can be identified in the O1s envelope, arising from the SiO<sub>2</sub> substrate support (531.8eV) and the Fe<sub>3</sub>O<sub>4</sub> nanowire material (529.6eV). The O1s signal arising from the SiO<sub>2</sub> dominates the spectrum due to the large amount of native SiO<sub>2</sub> at the substrate surface. The lower energy peak assigned to the Fe<sub>3</sub>O<sub>4</sub> is in good agreement with previously reported values for this material.[8,9]

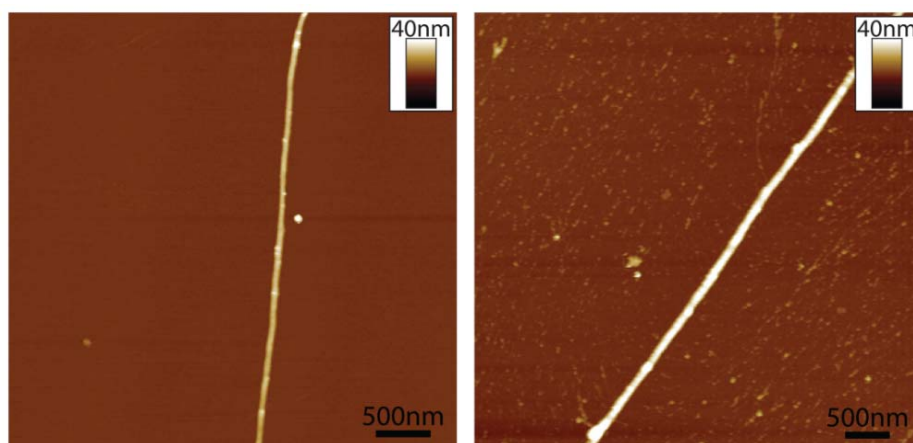


**Fig. S2** Raman spectra of samples of DNA/Fe<sub>3</sub>O<sub>4</sub> material prepared according to the experimental procedures detailed for in the main article for samples used in spectroscopic analysis (red spectra) and in scanning probe microscopy studies (blue spectrum). Both spectra show a band in the 665–680cm<sup>-1</sup>, characteristic of the A<sub>1g</sub> transition of iron oxide in the Fe<sub>3</sub>O<sub>4</sub> phase. The broad nature of this band in

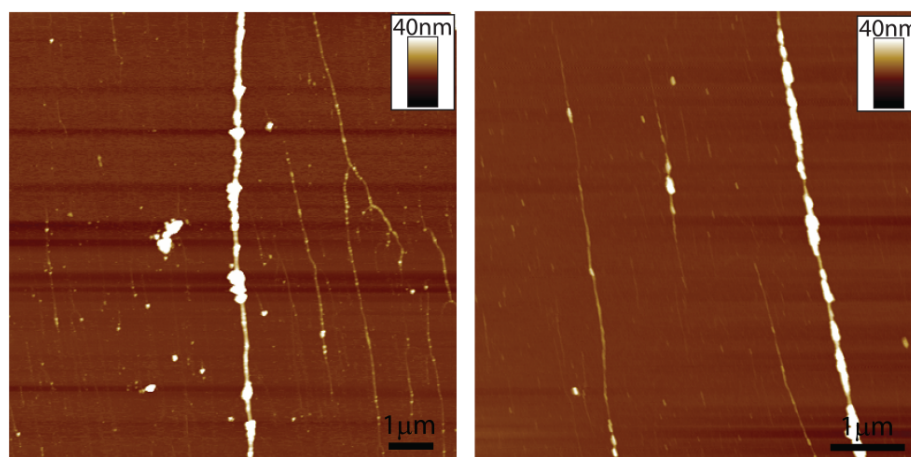
both spectra is a consequence of the small particle sizes of the  $\text{Fe}_3\text{O}_4$  material produced. Note the spectra have been normalised and offset for clarity.



**Fig. S3** TappingMode™ AFM height image showing DNA-templated  $\text{Fe}_3\text{O}_4$  structures isolated from a DNA/ $\text{Fe}_3\text{O}_4$  “powder” sample initially prepared for use in spectroscopic studies. Structures isolated from such powder samples typically showed the  $\text{Fe}_3\text{O}_4$  coatings upon the DNA to be of high roughness.



**Fig. S4** TappingMode™ AFM height images showing additional examples of  $\lambda$ -DNA-templated  $\text{Fe}_3\text{O}_4$  nanowires.



**Fig. S5** TappingMode™ AFM height images showing examples of partially formed  $\lambda$ -DNA-templated  $\text{Fe}_3\text{O}_4$  nanowires, where the metal oxide growth has not reach maturity during the reaction period.

### References

- [1] S. Alex and P. Dupuis, *Inorganica Chimica Acta*, 1989, **157**, 271-281.
- [2] A.A. Ouameur and H.-A. Tajmir-Riahi, *J. Biol. Chem.*, 2004, **279**, 42041-42054.
- [3] H. Arakawat, R. Ahmad, M. Naoui and H.-A. Tajmir-Riahi, *J. Biol. Chem.*, 2000, **275**, 10150-10153.
- [4] G. I. Dovbeshko, N. Y. Gridina, E. B. Kruglova and O. P. Pashchuk, *Talanta*, 2000, **53**, 233-246.
- [5] D. Sarkar and M. Mandal, *J. Phys. Chem. C*, 2012, **116**, 3227-3234.
- [6] F. Guo, Q. Zhang, B. Zhang, H. Zhang and L. Zhang, *Polymer*, 2009, **50**, 1887-1894.
- [7] Y. Sun, B. Wang, H. Wang, and J. Jiang, *J. Colloid Interf. Sci.*, 2007, **308**, 332-336.
- [8] Y. Tian, B. Yu, X. Li, K. Li, *J. Mater. Chem.*, 2011, **21**, 2476-2481.
- [9] T. Fujii, F. M. F. de Groot, G. A. Sawatzky, F. C. Voogt, T. Hibma, K. Okada, *Phys. Rev. B*, 1999, **59**, 3195-3202.