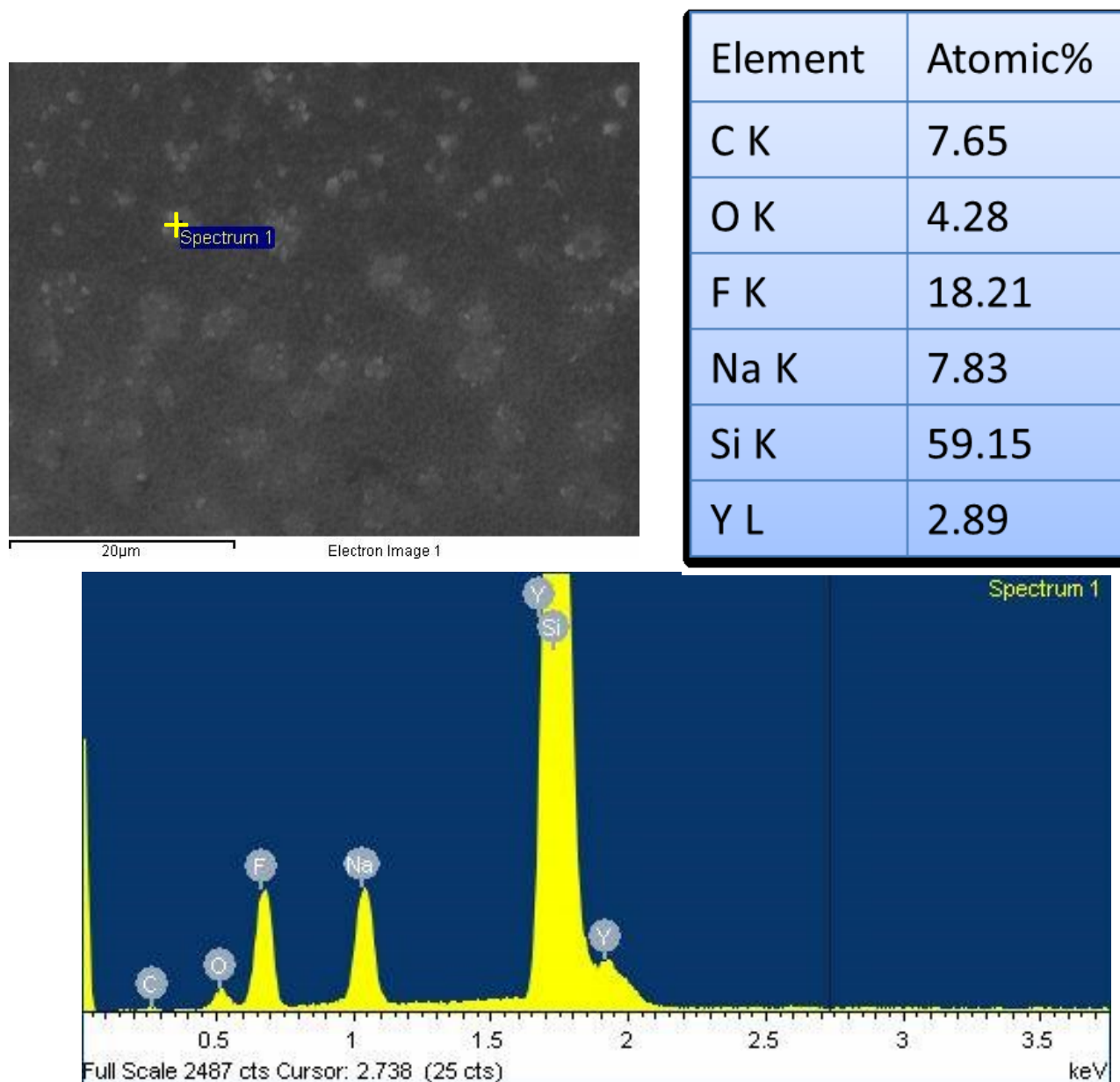


## Novel sol-gel fabrication of $\text{Yb}^{3+}/\text{Tm}^{3+}$ co-doped $\beta\text{-NaYF}_4$ thin films and investigation of their upconversion properties

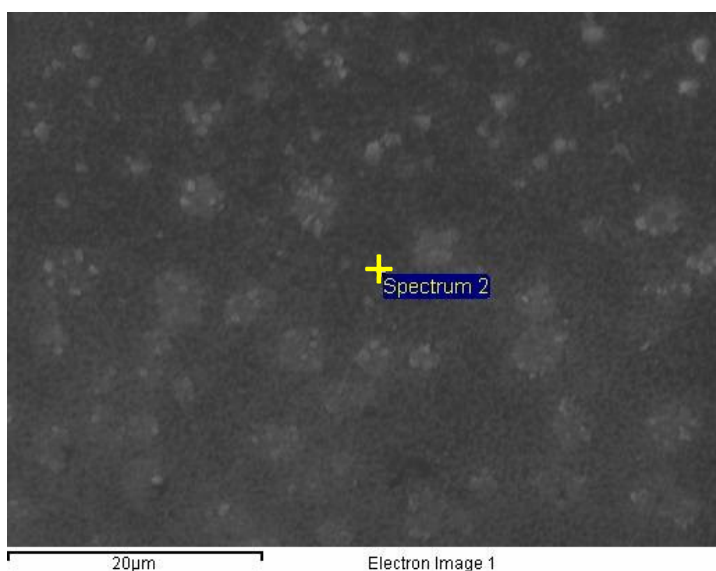
Anna L. Pellegrino,<sup>a</sup> Maria R. Catalano,<sup>a</sup> Paolo Cortelletti,<sup>b</sup> Giacomo Lucchini,<sup>b</sup> Adolfo Speghini,<sup>b</sup> and Graziella Malandrino<sup>a</sup>

<sup>a</sup>*Dipartimento di Scienze Chimiche, Università di Catania and INSTM UdR Catania, V.le A. Doria 6, 95125 Catania, Italy.*

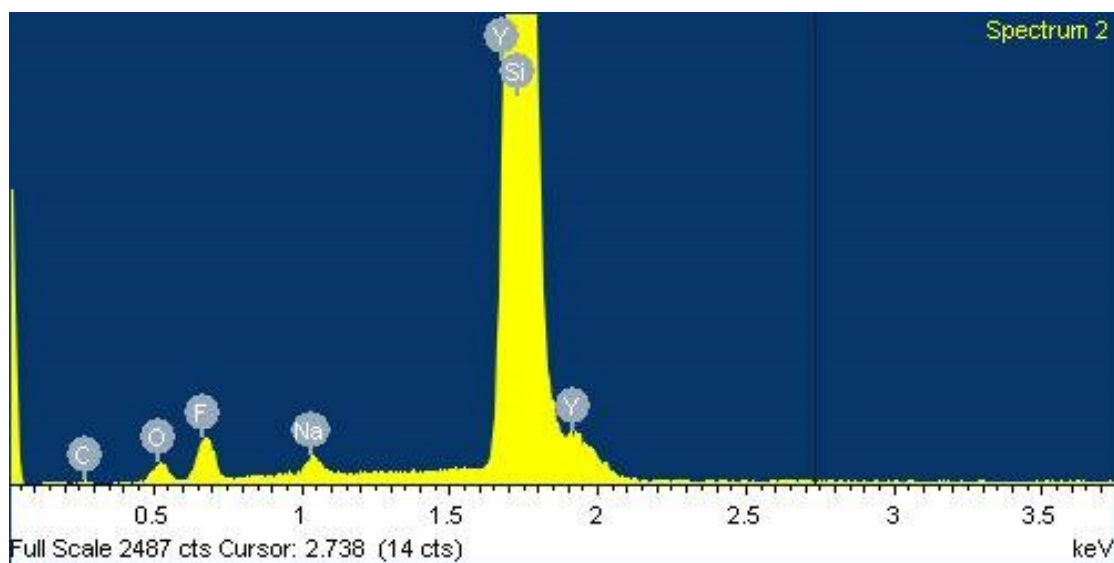
<sup>b</sup>*Nanomaterials Research Group, Dipartimento di Biotecnologie, Università di Verona and INSTM UdR Verona, Strada le Grazie 15, 37134 Verona, Italy.*



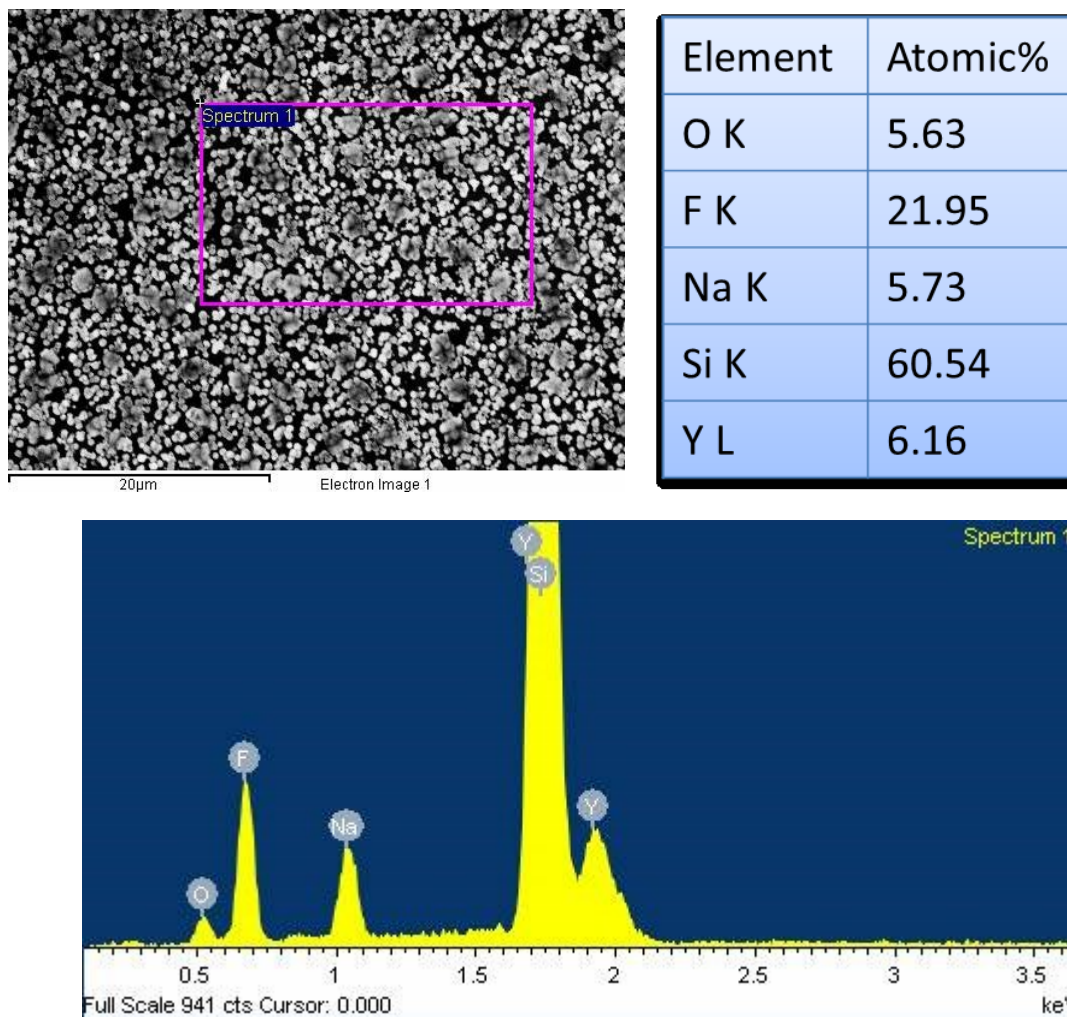
**Fig S1.** EDX spectrum recorded in position **1** of the sample obtained through route 1.



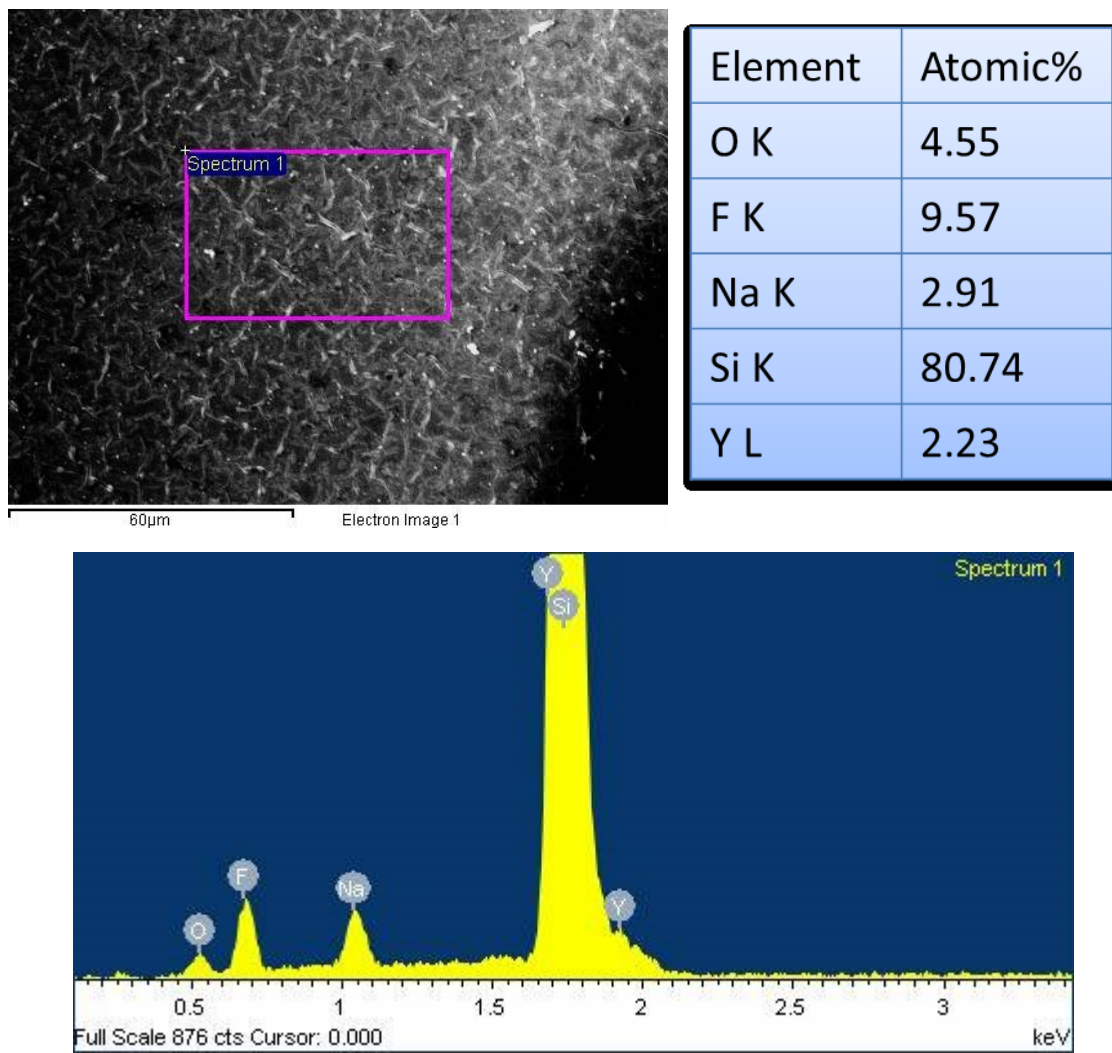
Element	Atomic%
C K	8.01
O K	5.55
F K	7.32
Na K	1.11
Si K	74.80
Y L	3.22



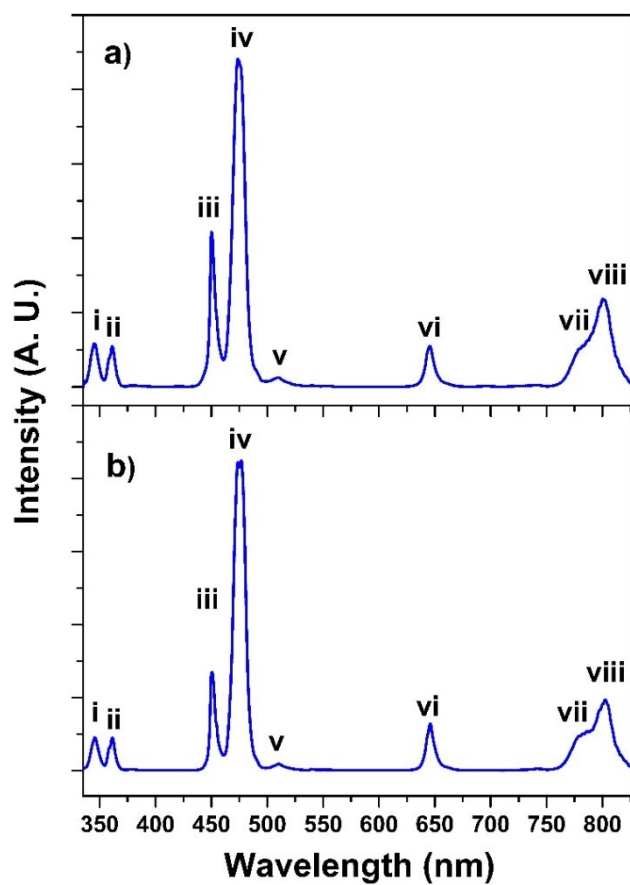
**Fig S2.** EDX spectrum recorded in position **2** of the sample obtained through route 1.



**Fig S3.** EDX spectrum recorded in one side of the sample obtained through route 2.



**Fig S4.** EDX spectrum recorded on the other side of the sample obtained through route 2.



**Fig S5.** UC emission spectra of single layer **(a)** NaYF<sub>4</sub>: Tm(0.5%), Yb(18%) sample grown on silicon and **(b)** NaYF<sub>4</sub>: Tm(0.5%), Yb(18%) sample grown on quartz. Assignments of the emission bands corresponding to Tm<sup>3+</sup> ion transitions: (i) <sup>1</sup>I<sub>6</sub>→<sup>3</sup>F<sub>4</sub>, (ii) <sup>1</sup>D<sub>2</sub>→<sup>3</sup>H<sub>6</sub>; (iii) <sup>1</sup>D<sub>2</sub>→<sup>3</sup>F<sub>4</sub>; (iv) <sup>1</sup>G<sub>4</sub>→<sup>3</sup>H<sub>6</sub>, (v) <sup>1</sup>D<sub>2</sub>→<sup>3</sup>H<sub>5</sub>, (vi) <sup>1</sup>G<sub>4</sub>→<sup>3</sup>F<sub>4</sub>, (vii) <sup>1</sup>G<sub>4</sub>→<sup>3</sup>H<sub>5</sub>, (viii) <sup>3</sup>H<sub>4</sub>→<sup>3</sup>H<sub>6</sub>.