Absolute up-conversion quantum efficiency reaching 4% in $\beta$-NaYF$_4$:Yb$^{3+}$,Er$^{3+}$ micro-cylinders achieved by Li$^+$/Na$^+$ ion-exchange

Shaohua Fan$^{1,2}$, Guojun Gao$^{1,3,*}$, Shiyu Sun$^1$, Sijun Fan$^1$, Hongtao Sun$^4$, Lili Hu$^1,*$

$^1$Key Laboratory of Materials for High Power Laser, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai 201800, China

$^2$University of Chinese Academy of Sciences, Beijing 100049, China

$^3$Institute of Microstructure Technology, Karlsruhe Institute of Technology (KIT), Eggenstein-Leopoldshafen 76344, Germany

$^4$College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou 215123, China

*Corresponding authors: G. Gao: guojun.gao@hotmail.com; L. Hu: hulili@siom.ac.cn

**Fig. S1.** The variation of decay curves of green UC emission for Li$^+$/Na$^+$ IEM $\beta$-NaYF$_4$:20$\%$Yb$^{3+}$,2$\%$Er$^{3+}$ synthesized with LiF/NaF = 40/60 dependent on the pump power density (976 nm, 0.8 – 4.8 W/cm$^2$).