

Enhanced response of infrared photodetector based on reduced graphene oxide and up-conversion microparticles

Vuong Thanh Tuyen^{1,2}, Duc Anh Ngo^{1,2}, Le Thai Duy^{1,2},
Nguyen Duc Hao^{1,2}, Nhu Hoa Tran Thi^{1,2}, Vinh Quang Dang^{1,2}, Tran T.T Van^{1,2*}

1. Faculty of Materials Science and Technology, University of Science, Ho Chi Minh City, Vietnam
2. Vietnam National University Ho Chi Minh City, Vietnam

* Corresponding email: tttvan@hcmus.edu.vn

Preparation of the up-conversion microparticle NaYF₄: 0.5% Tm, 30% Yb

The synthesis of the NaYF₄: 0.5% Tm, 30% Yb UCMPs sample was performed in two stages, starting with the preparation of RE stearate (**Figure S1a**). Firstly, RE(NO₃)₃·6H₂O, stearic acid, and ethanol were stirred at 54°C for 30 min. Next, system was heated to 74°C, drop NaOH solution and continue stir in 40 min. Then, it was washed with ethanol and dried at 60°C for 12h. Finally, RE stearate (TmS, YbS, YS) was obtained as a white powder.

The second process for the fabrication of UCMPs was carried out as shown in **Figure S1b**. To begin with, water, ethanol, and oleic acid were stirred for 30 min. Then mixture of TmS, YbS, YS, and NaF were added and stirred for 30 min. Next, a hydrothermal process was carried out in an steel tank at 180°C for 24 h. A yellowish solution was obtained, then centrifuged and washed with chloroform and ethanol at a ratio of 1:6. Finally, white powder UCMPs NaYF₄: 0.5% Tm, 30% Yb was obtained after drying at 100°C for 12 h.

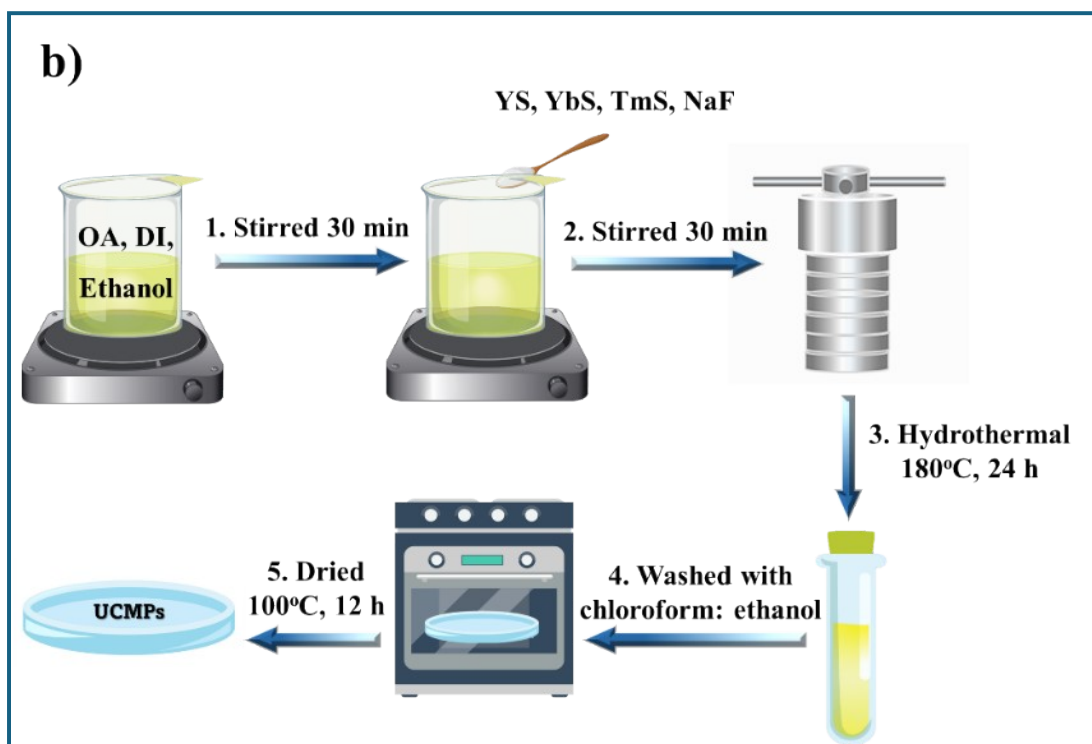
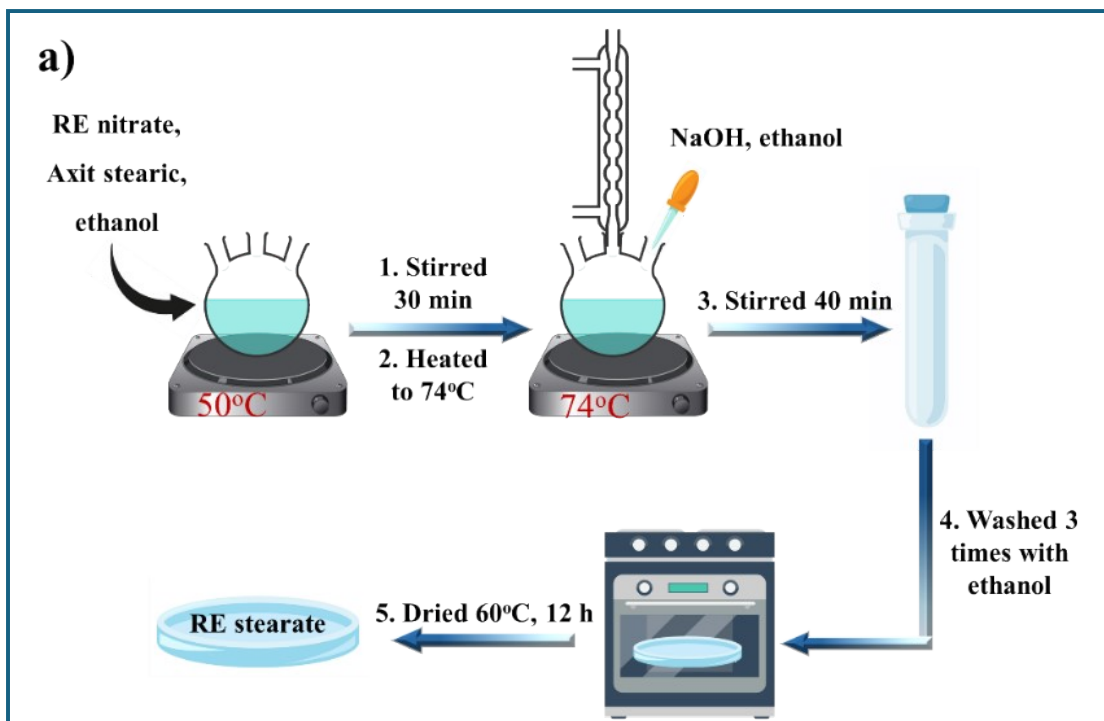


Figure S1. Fabrication process of a) RE stearate and b) upconversion luminescent nanoparticles (UCMPs).

Structural characteristics and surface morphology

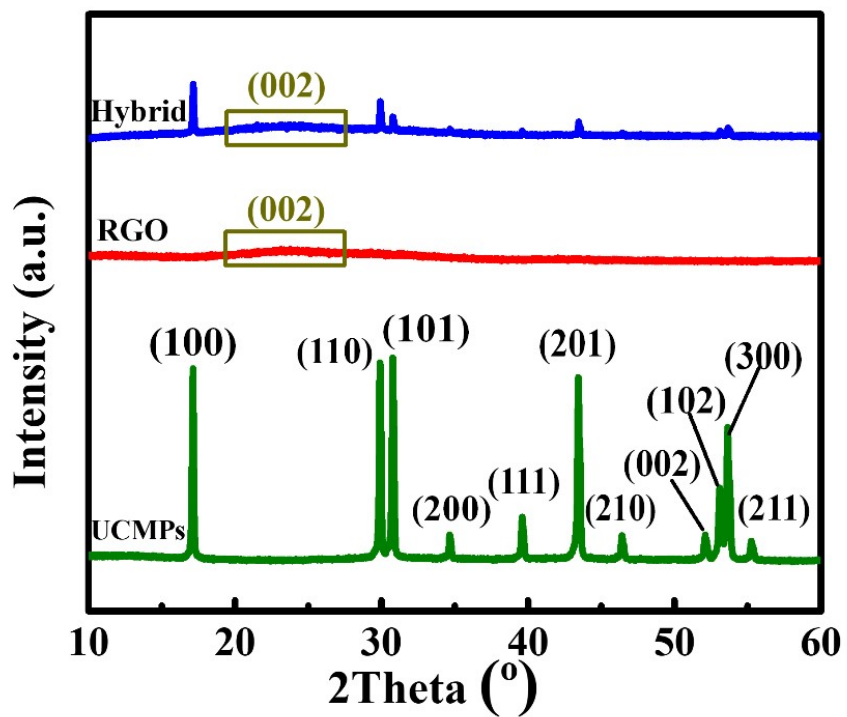


Figure S2. XRD pattern of UCMPs, RGO and hybrid UCMPs/RGO

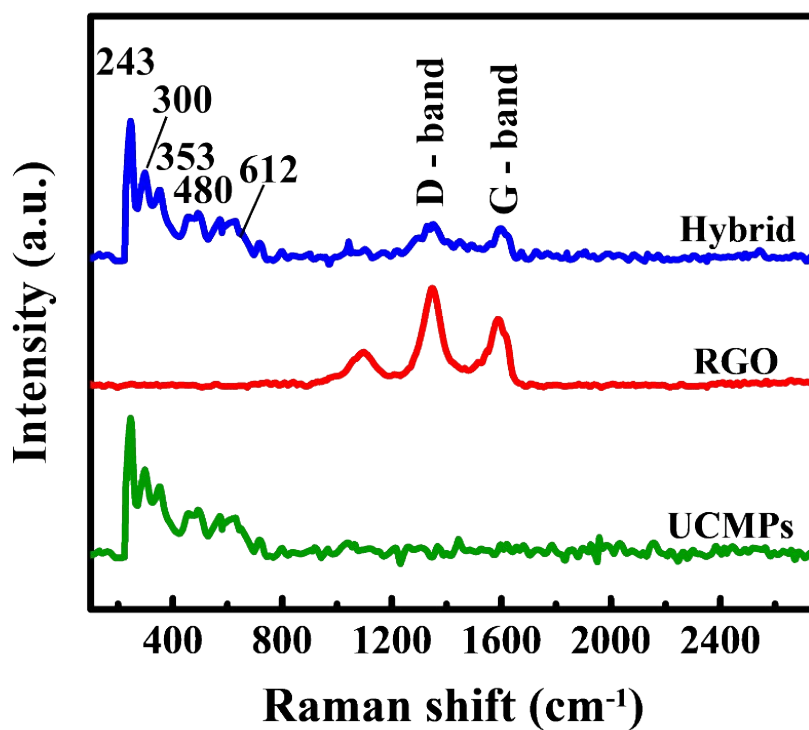


Figure S3. Raman spectrum of UCMPs, RGO and hybrid UCMPs/RGO

Characteristic properties of IR photodetectors

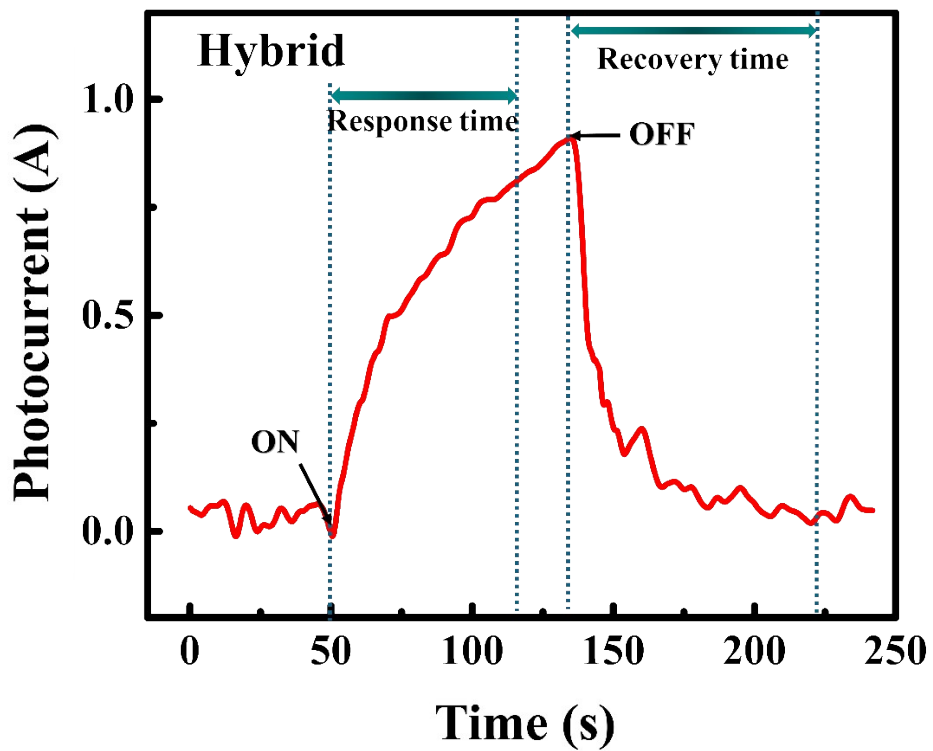


Figure S4. *Response and recovery time of photodetector UCMPs/RGO hybrid under 980 nm*

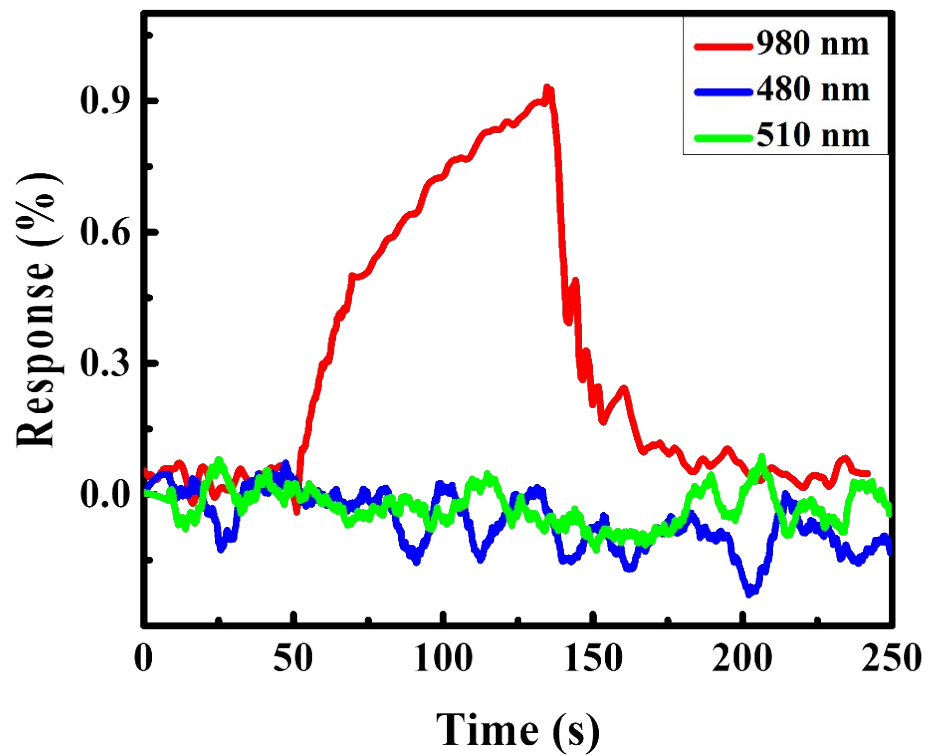


Figure S5. Response of photodetector UCMPs/RGO hybrid under 980 nm, 480 nm, 510 nm LED illumination.