Electronic supporting information (ESI)

Scalable synthesis of $Ti_3C_2T_X$-arginine and serine functionalized graphene quantum dot microsphere for high performance supercapacitors

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1. Experimental Section

1.1. Synthesis of $Ti_3C_2T_X$

Lithium fluoride and hydrochloric acid were used to etch MAX-Ti_3AlC_2. The specific steps were as follows: 40mL hydrochloric acid (9M) and 3.2g lithium fluoride were added to the Teflon beaker and stirred for 30min. Then 2g MAX-Ti_3AlC_2 was slowly added and the reaction was carried out at 35℃ for 36h. After the reaction, the product was separated at 3500rpm for 5min until the pH value of the liquid was 5-7. Then, 40mL ethanol was added to the centrifuge tube for 30min, and then centrifuged at 10000rpm and 10min to collect the sediment in the lower layer. Deionized water was added to the centrifuge tube with sediment, mixed evenly by vortex, and the dark green upper liquid was collected by centrifugation at 3500rpm for 5min.

1.2. Material characterization

Scanning electron microscope (SEM) analysis was carried out in HITACHI S-4800 field emission scanning electron microscope. SEM sample was prepared by placing a drop of dilute ethanol dispersion of the composites onto a copper plate attached to an aluminum sample holder, and the solvent was allowed to evaporate at room temperature. Transmission electron microscope (TEM) images were conducted on a JEOL 2010plus

transmission electron microscope at 200 keV. The sample was prepared by dispensing a small amount of dry powder in ethanol. Then, one drop of the suspension was dropped on 300 mesh copper. TEM grids covered with thin amorphous carbon films. X-ray diffraction (XRD) pattern was measured on X-ray D8 Advance Instrument operated at 40 kV and 20 mA and using a Cu Kα radiation source with λ=0.15406 nm. X-ray photoelectron spectroscopy (XPS) was carried out in a PHI 5700 ESCA spectrometer with mono chromated Al KR radiation. The Infrared spectrum (IR) was tested using Nicolet FT-IR 6700 spectrometer. Atomic force microscopic (AFM) images were taken by Multimode 8 Force Microscope (Bruker, Germany). The UV-visible diffuse reflectance spectra (DRS) was measured on Shimadzu UV-3600 Plus. Zeta potential measurements were completed at ZetaPALS(Brookhaven Instruments, Inc).

2. Figures

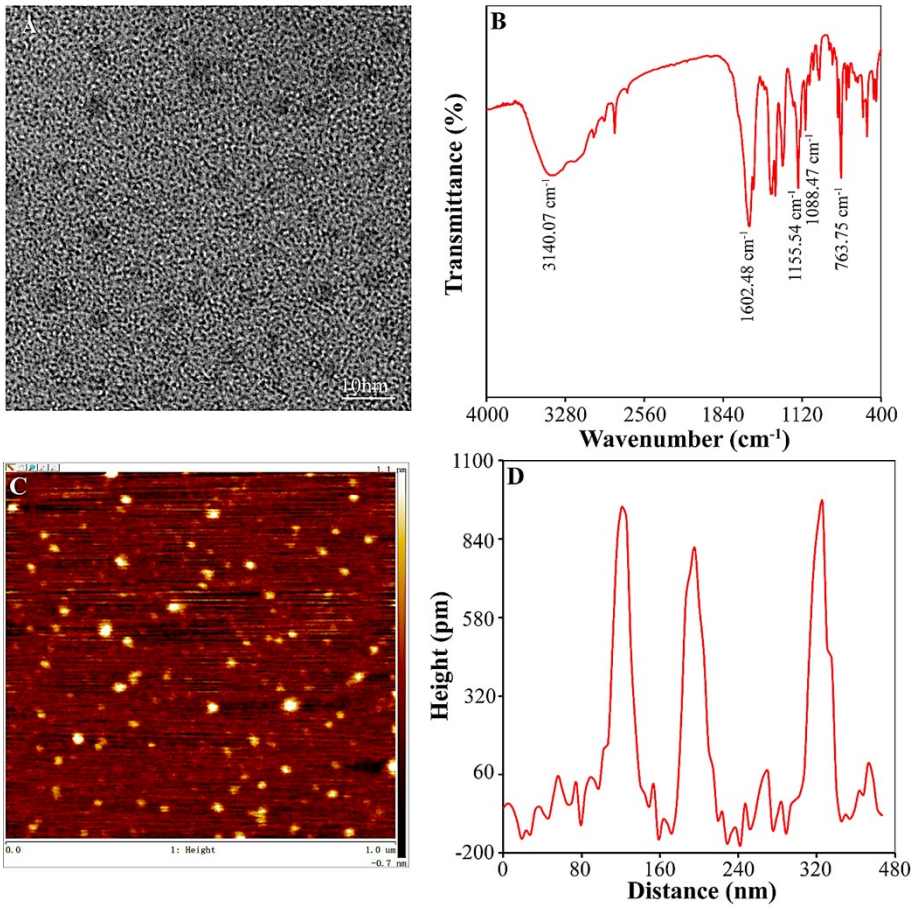

Fig. s1 TEM image (A), FTIR spectrum (B) and AFM image (C , D) of Arg-GQD-Ser

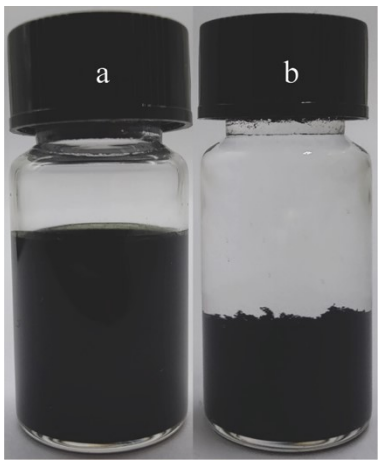

Fig. s2 Optical photographs of the $Ti_3C_2T_X$ aqueous solution before (a) and after added 10% Arg-GQD-Ser

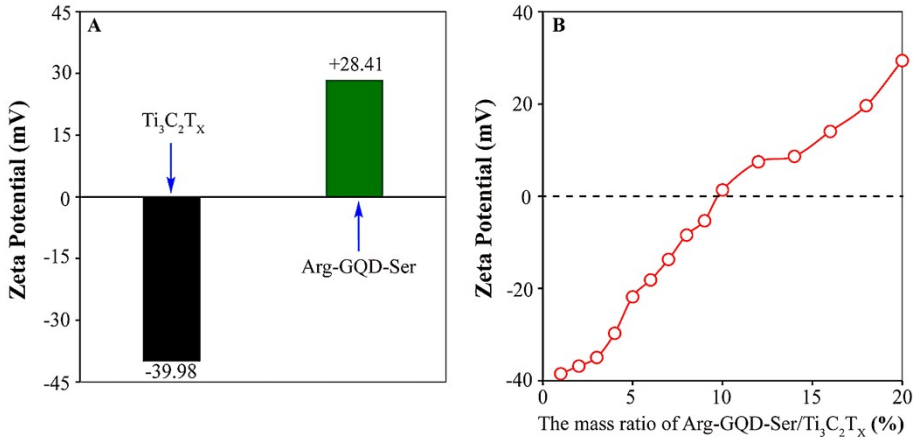

Fig. s3 Zeta potential values of $Ti_3C_2T_X$ and Arg-GQD-Ser (A) and change in the Zeta potential during addition of Arg-GQD-Ser

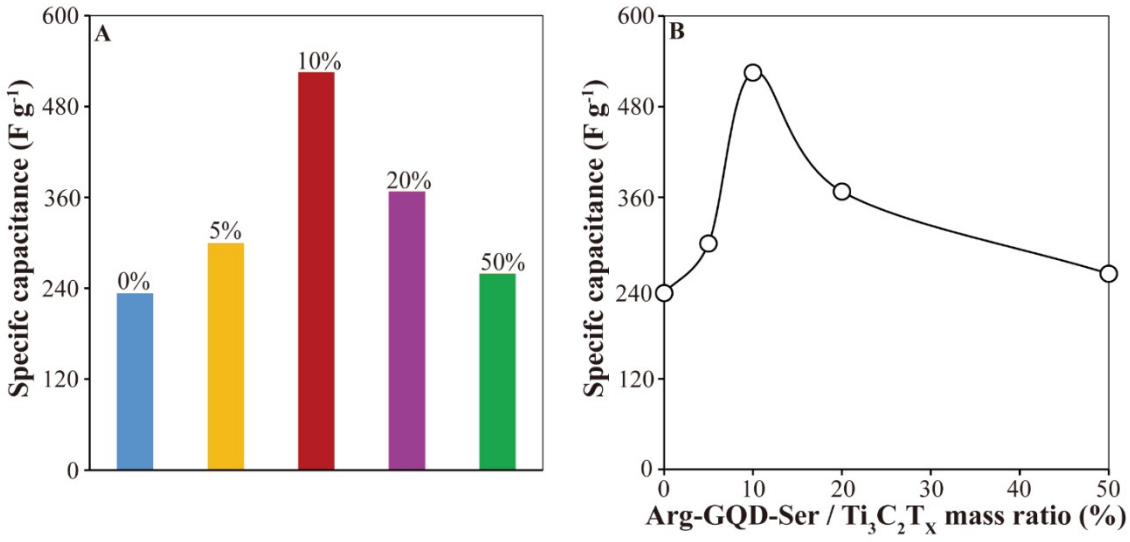

Fig. s4 The specific capacitances of $Ti_3C_2T_X$/Arg-GQD-Ser composite electrode with different amounts of content of Arg-GQD-Ser

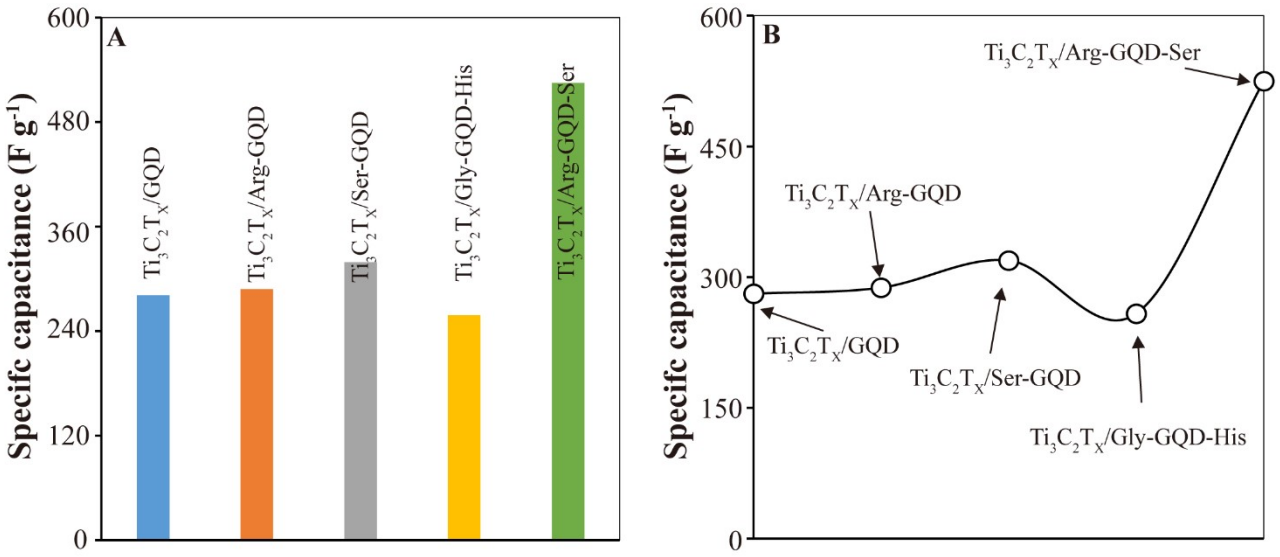

Fig. s5 The specific capacitances at the current density of 1.0 A g^{-1} of $Ti_3C_2T_X$/Arg-GQD-Ser electrodes containing different graphene quantum dots

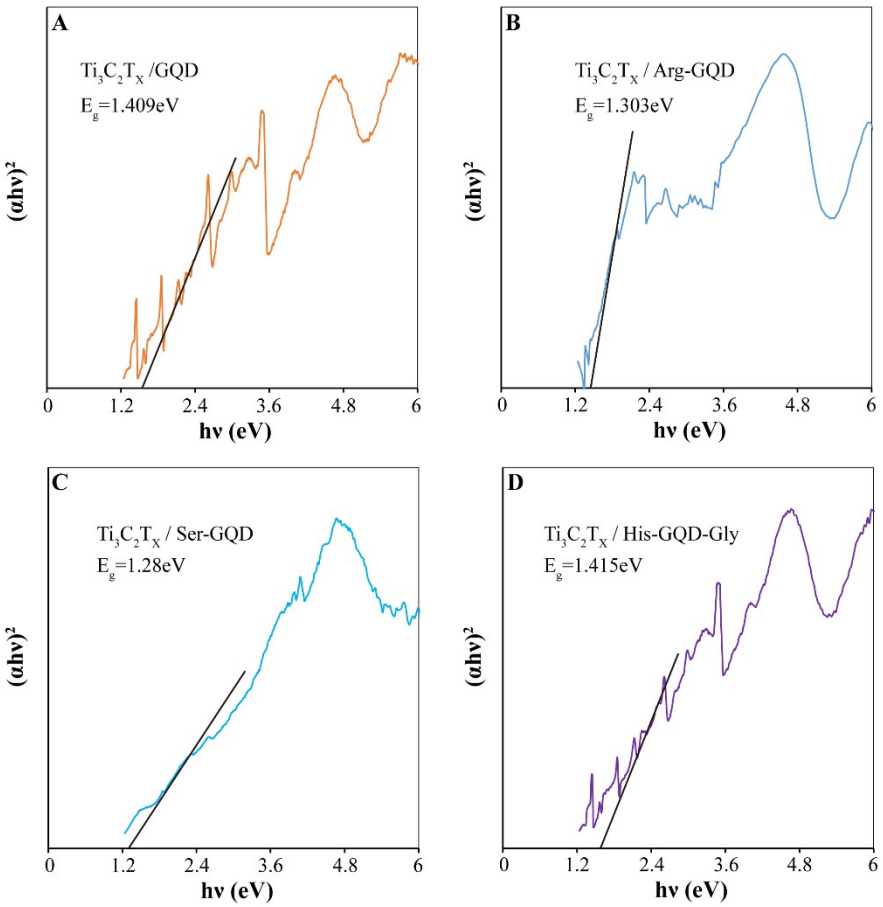

Fig. s6 The relationship curves of $(\alpha h\nu)^2$ with $h\nu$ of $Ti_3C_2T_x$/Ser-GQD (A), $Ti_3C_2T_x$/GQD(B), $Ti_3C_2T_x$/His-GQD-Gly(C) and $Ti_3C_2T_x$/Arg-GQD (D)

3. Tables

Table s1 EIS Parameters of different materials

Electrode	$R_S(\Omega)$	$R_{CT}(\Omega)$
Arg-GQD-Ser	3.094	578.8
$Ti_3C_2T_X$ /Arg-GQD-Ser	3.012	0.31
$Ti_3C_2T_X$ /GQD	3.075	0.6726
$Ti_3C_2T_X$ /Arg-GQD	3.074	1.171
$Ti_3C_2T_X$ /Ser-GQD	3.051	1.045
$Ti_3C_2T_X$ /Gly-GQD-His	3.072	0.7881
$Ti_3C_2T_X$ /Arg-GQD-Ser(5wt%)	3.0533	1.533
$Ti_3C_2T_X$ /Arg-GQD-Ser(20wt%)	3.035	4.492
$Ti_3C_2T_X$ /Arg-GQD-Ser(50wt%)	3.069	6.026