Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Surface Functionality Density Regulated In-Situ Reduction of Nanosilver on Hierarchial Wrinkled Mesoporous Silica Nanoparticles and Their Antibacterial Activity

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Instruments and characterization process

High resolution transmission electron microscopic (HRTEM) and scanning electron microscopic (SEM) images of the obtained samples are taken on a JEOL-3000F electron microscope and a Hitachi-S4800FESEM. Powder X-ray diffraction (XRD) patterns are recorded on an X-ray diffractometer (D8 ADVANCE SS, Gemany) with monochromated Cu-Karadiation (λ=1.54060 Å) at a scanning rate of 5.0^{o} min^{-1}. The Brunauer-Emmett-Teller (BET) surface area is determined by nitrogen adsorption and desorption using a specific surface area analyzer (Micromeritics ASAP 2020, USA).Using the Barrett-Joyner-Halenda (BJH) model, the pore volumes and pore size distributions are derived from the desorption branches of isotherms. The weight content of Ag NPs in the obtained samples is measured by an inductively coupled plasma mass spectrometer (ICP-MS, XSenes7, USA). The content of amino groups on the surface of WMSs was determined by the argentometric titration with 0.1 N $AgNO_3$ following neutralization with HCl.[1]

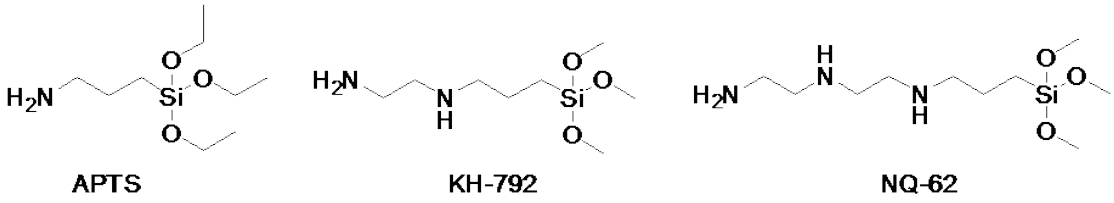

Figure S1. The structural formulas of APTES, KH-792 and NQ-62.

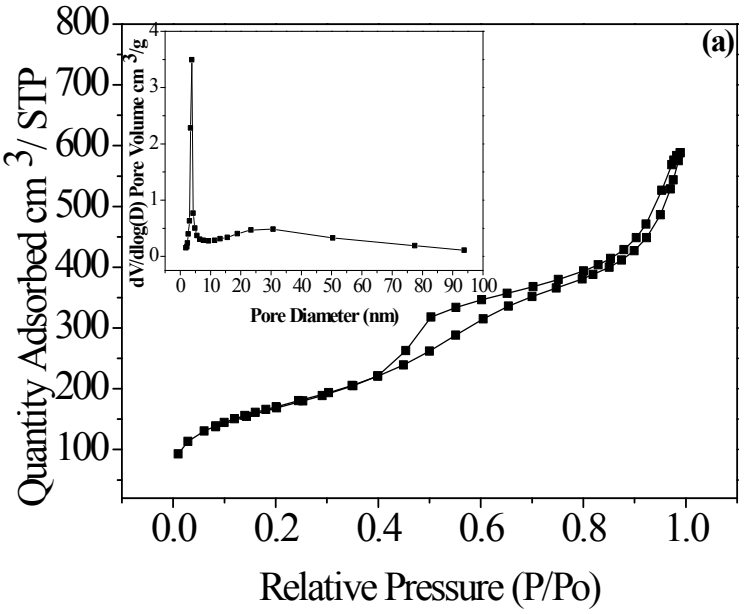

Figure S2. N_2 absorption/desorption isotherms and pore size distribution of WMSs-N nanoparticles.

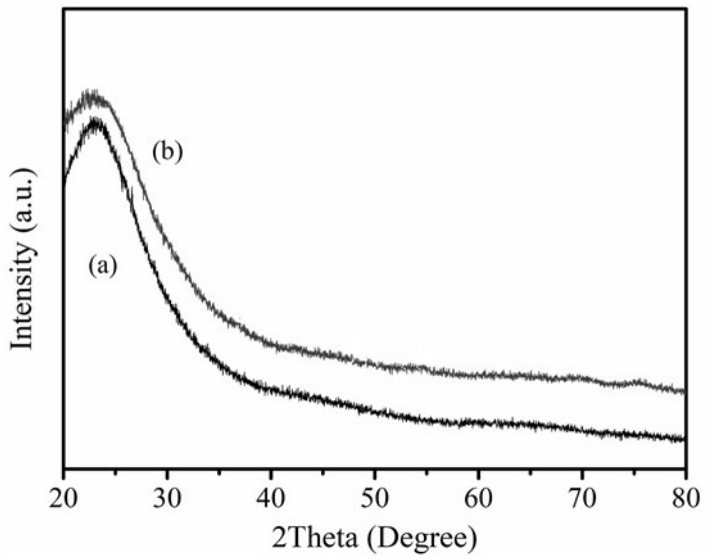

Figure S3. XRD patterns obtained for (a) Ag@WMSs-N and (b) WMSs-N nanoparticles.

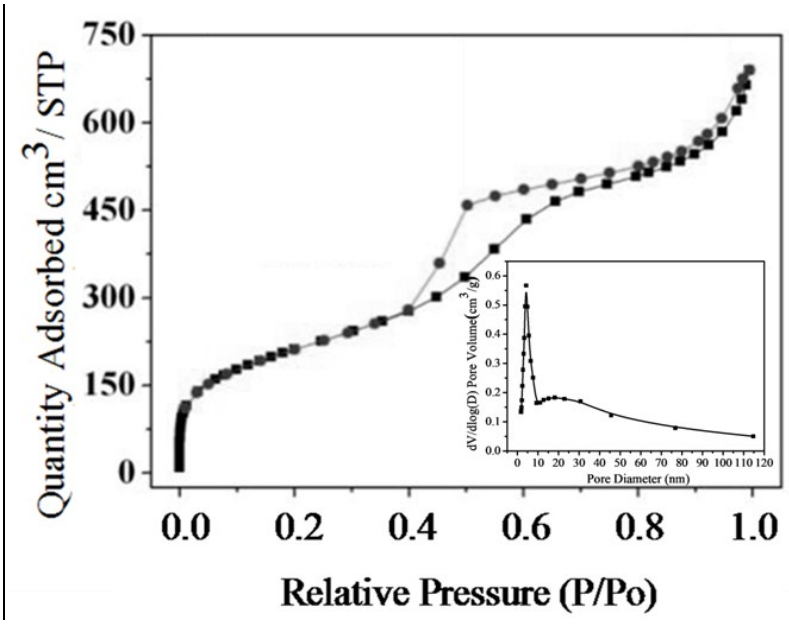

Figure S4. N_2 absorption/desorption isotherms and pore size distribution of WMSs-NN nanoparticles.

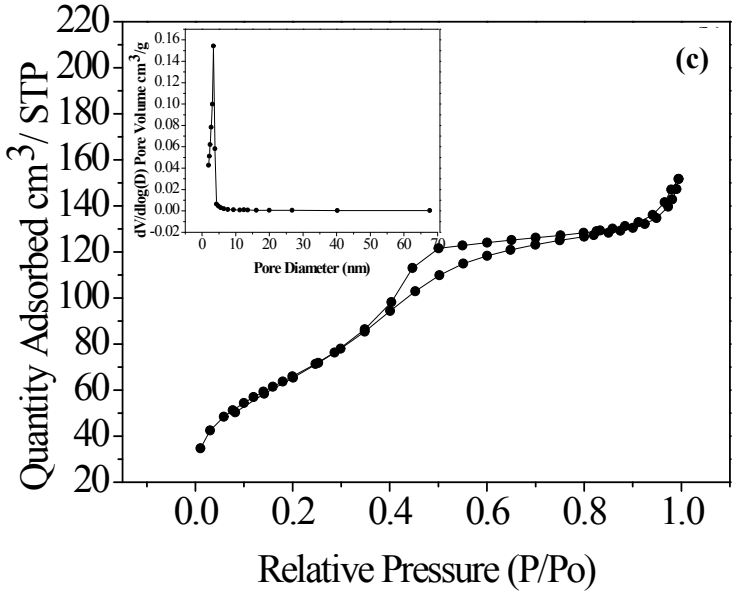

Figure S5. N_2 absorption/desorption isotherms and pore size distribution of WMSs-NNN nanoparticles.

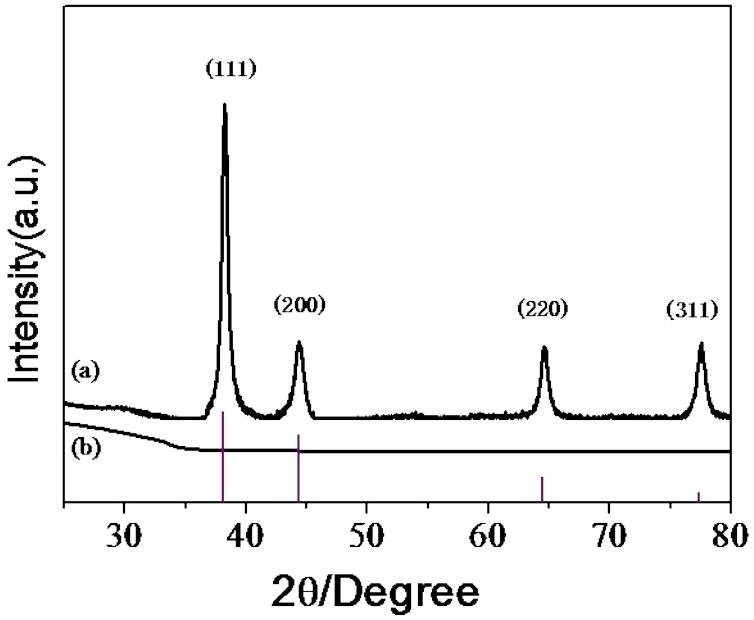

Figure S6. XRD patterns obtained for (a) Ag@WMSs-N2 and (b) WMSs-N2 nanoparticles.

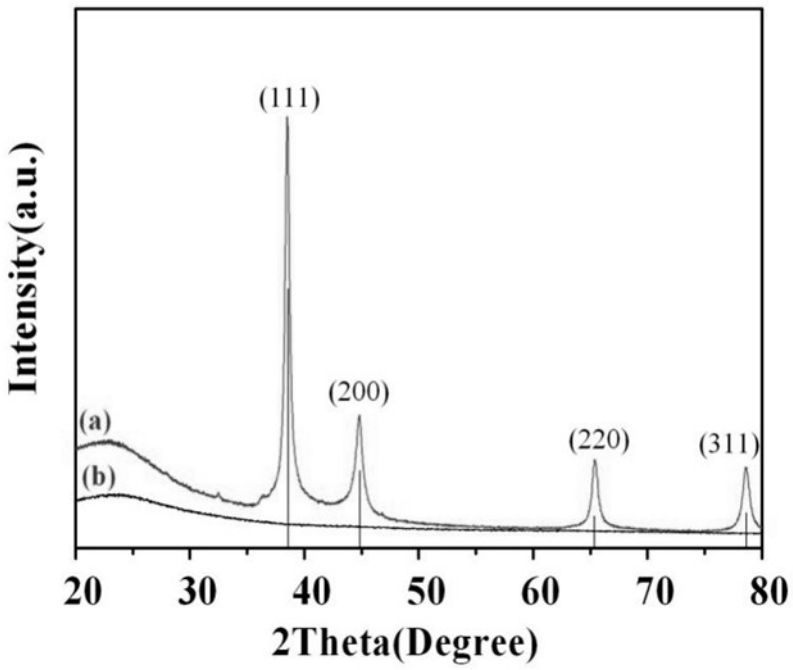

Figure S7. XRD patterns obtained for (a) Ag@WMSs-NN and (b) WMSs-NN nanoparticles.

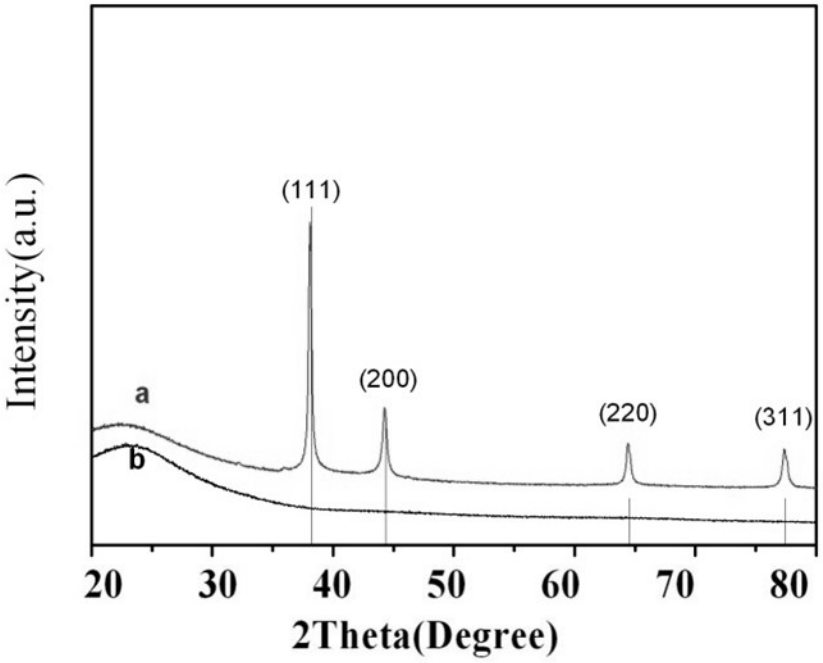

Figure S8. XRD patterns obtained for (a) Ag@WMSs-NNN and (b) WMSs-NNN nanoparticles.

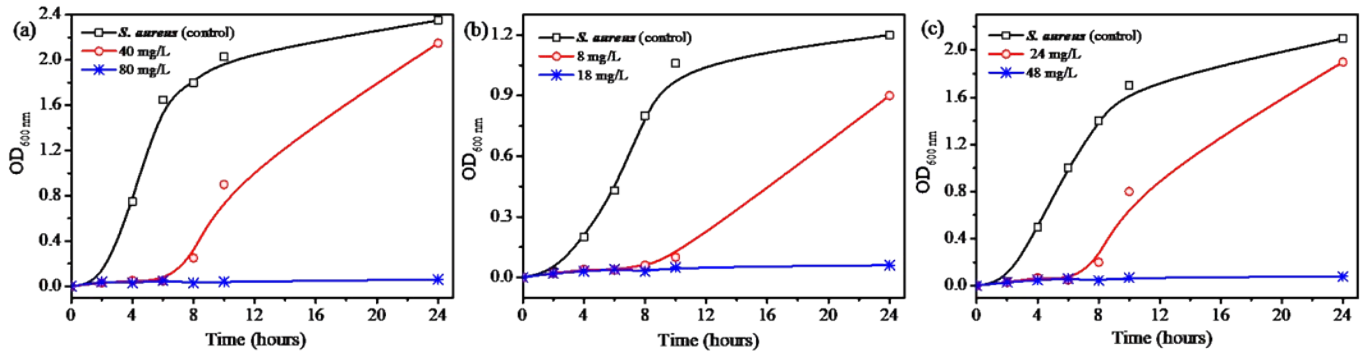

Figure S9. Concentration effects for the bacterial growth with the addition of Ag@WMSs-N2 (a), Ag@WMSs-NN (b) and Ag@WMSs-NNN (c) toward S.aureus.

Table S1. Structural properties of WMSs-N, WMSs-N2, WMSs-NN and WMSs-NNN nanoparticles.

Sample	Surface area	Pore volume	Amino group[a]	
	$m^2\ g^{-1}$	$cm^3\ g^{-1}$	$mmol\ g^{-1}$	nm^{-2}
WMSs-N	602.32	0.91	0.47	0.47
WMSs-N2	525.98	0.97	0.90	1.03
WMSs-NN	768.83	1.03	1.66	1.31
WMSs-NNN	241.83	0.23	0.36	0.86

[a]The content of amino groups on the surface of WMSs was determined by the argentometric titration using 0.1 N $AgNO_3$. The surface density of amino groups was based on the surface area of WMSs.

Table S2. Comparision of the MIC and MBC values of Ag@WMSs obtained in our work and the reported others.

Sample	*E. coli*		*S. aureus*		References
	MIC ($mg\ L^{-1}$)	MBC ($mg\ L^{-1}$)	MIC ($mg\ L^{-1}$)	MBC ($mg\ L^{-1}$)	
Ag@WMSs-N2	40	96	80	108	
Ag@WMSs-NN	24	48	48	96	This work
Ag@WMSs-NNN	12	24	18	36	
Ag-HeiQ AGS-20	62	\	250	\	Ref. 31
Ag-SiO_2-3	300	\	500	\	Ref. 32
CaMSS-0.5N-Ag	100	\	\	\	Ref. 24
Ag-MSNs	80	\	320	\	Ref. 22

Reference:

1. T. Yokoi, H. Yoshitake and T. Tatsumi, *J Mater Chem*, 2004, **14**, 951-957.