Electronic Supplementary Material (ESI) for RSC Advances.
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# Supporting Information

## Smartphone-assisted microfluidic and spectrophotometric recognition of hydrazine: A new platform towards rapid analysis of carcinogenic agents and environmental technology

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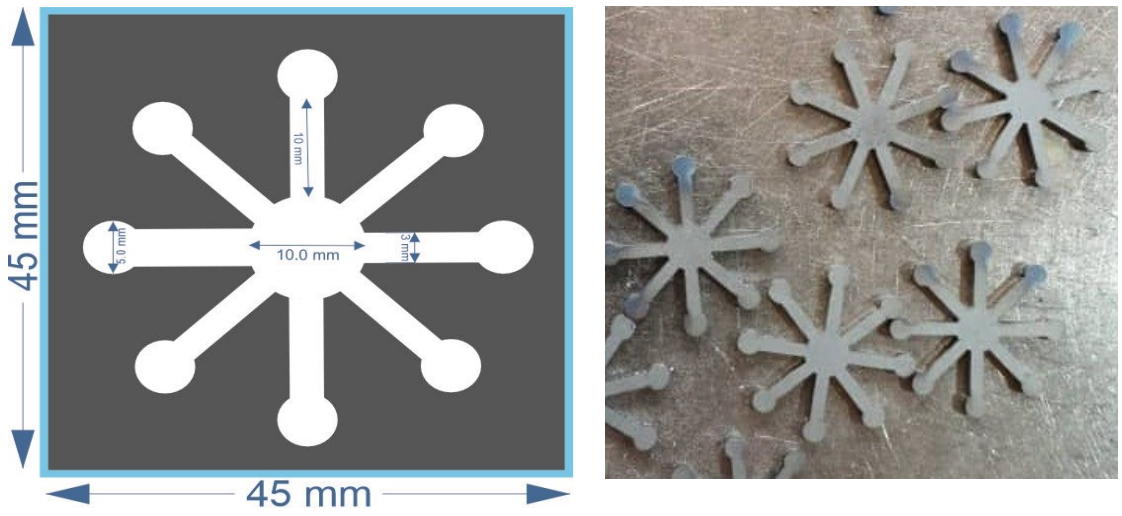



**Scheme. S1. A)** Pattern designed by the AutoCAD software to make a stainless-steel mold with dimensions' d = 5 mm for the peripheral circles, d = 10 mm for the central circle, 10 mm for the length of the channels, and 3 mm meters for the width of the channels. **B)** Photographic Images of fabricated steel patterns.

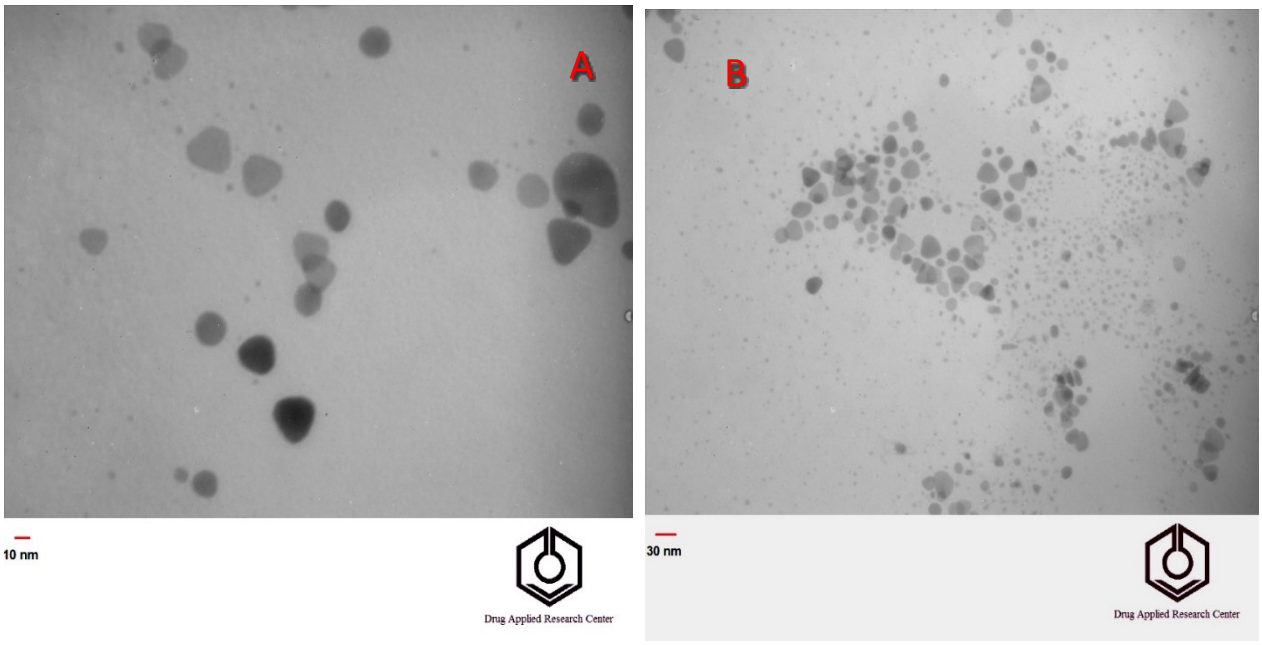



**Fig. S1.** TEM images of Ag NPrs in different magnification 10 nm **A)** and 30 nm **B)**

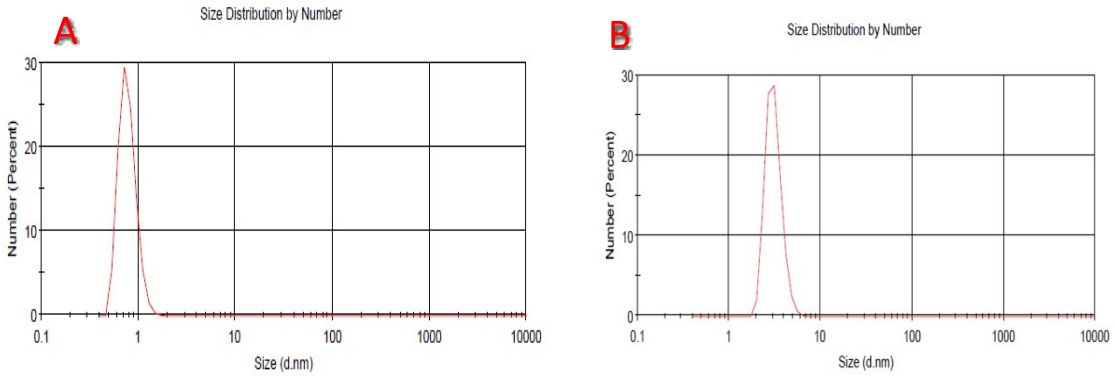



**Fig. S2.** DLS plot of: **A)** Ag NPrs, **B)** combination of Ag NPrs and Hyd (immediately, t = 0s)

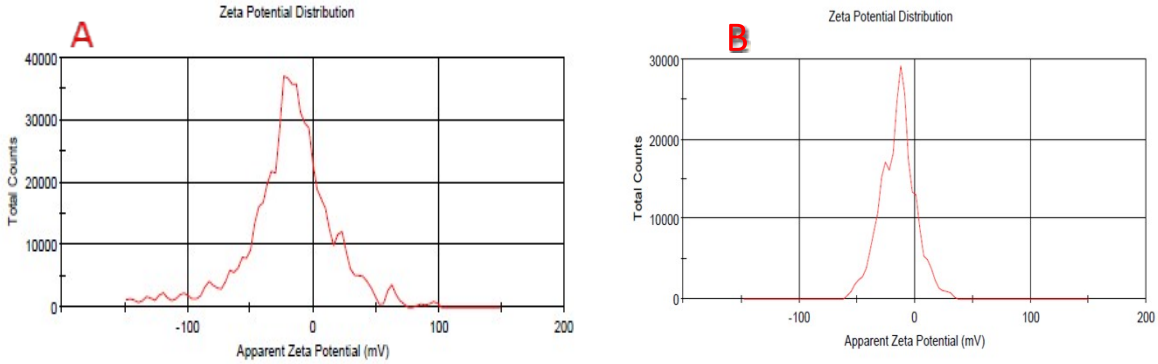



**Fig. S3.** Zeta potential of **A)** Ag NPrs, **B)** combination of Ag NPrs and Hyd (immediately, t = 0s)

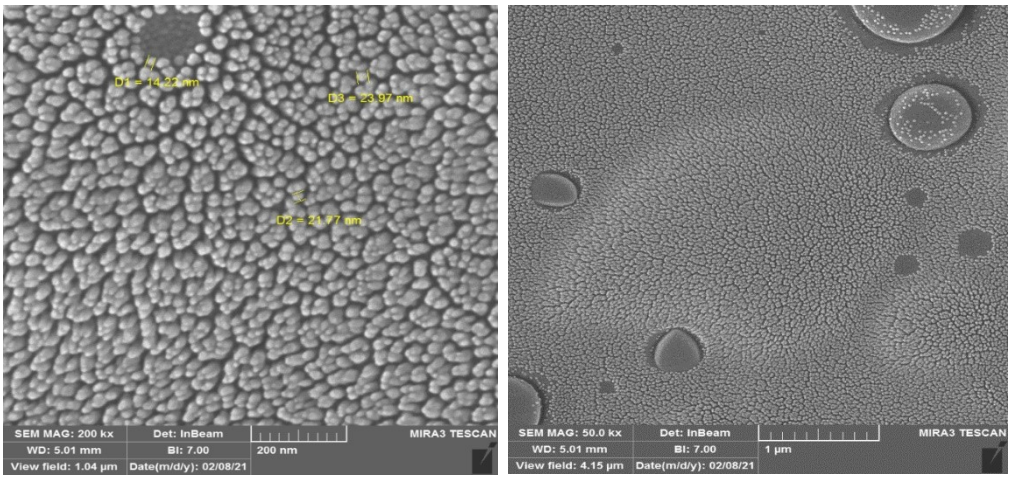



**Fig. S4.** FE-SEM images of Ag NPrs in different magnification.

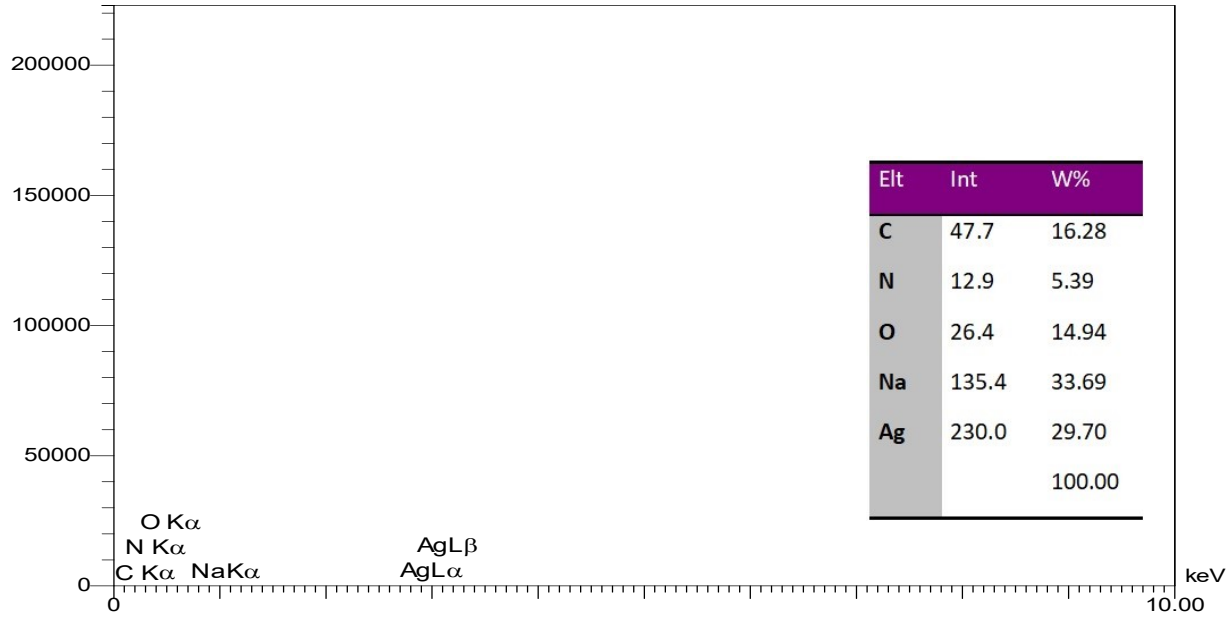



**Fig. S5.** EDS spectra of Ag NPrs.

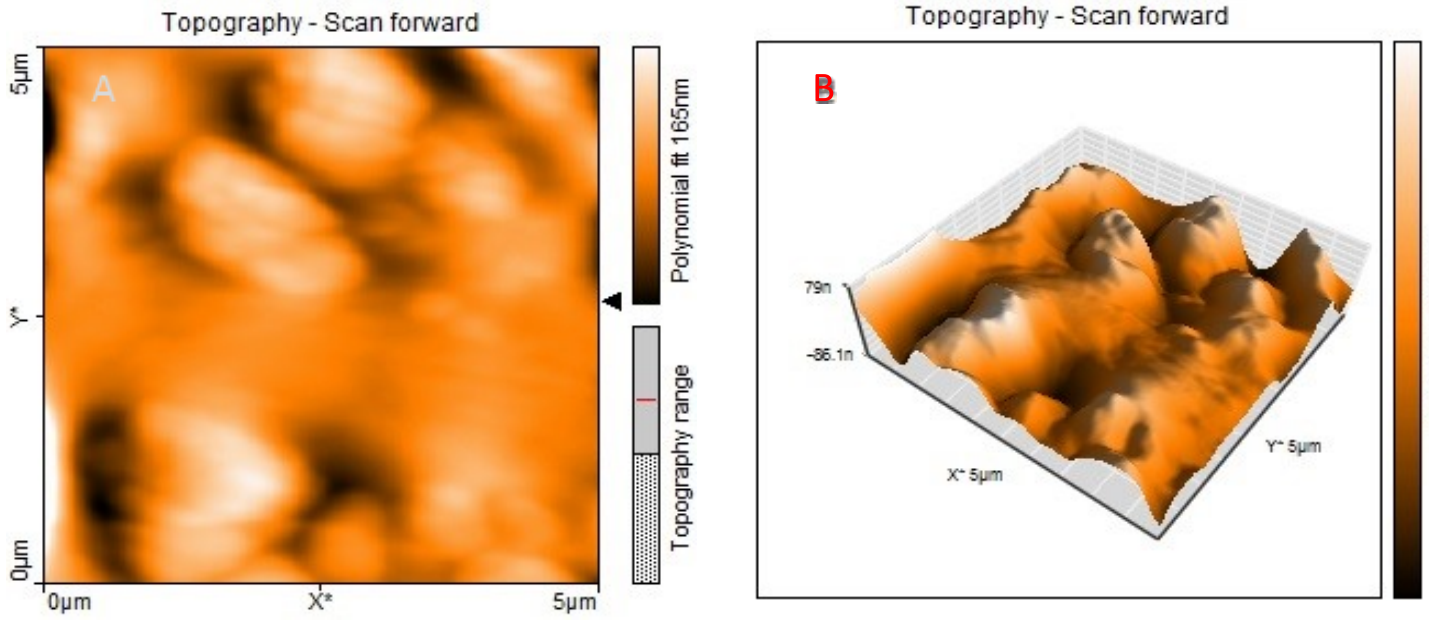



**Fig. S6.** Topographic AFM images of Ag NPrs in 2D, (**A)** and 3D, (**B)** view.

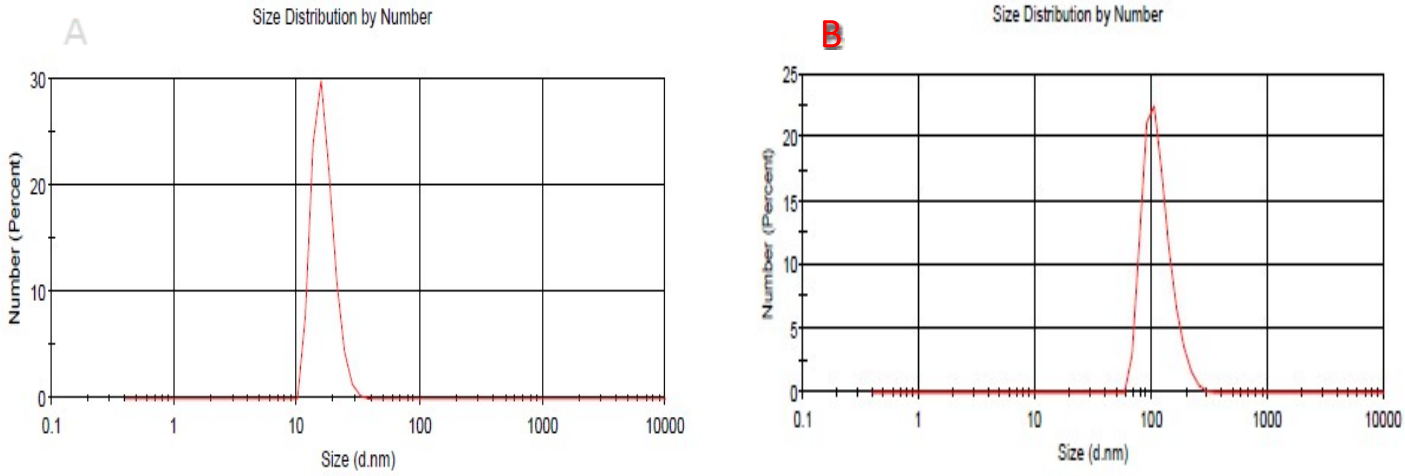



**Fig. S7.** DLS plot of **A)** Ag NWs, **B)** combination of Ag NWrs and Hyd (immediately, t = 0s)

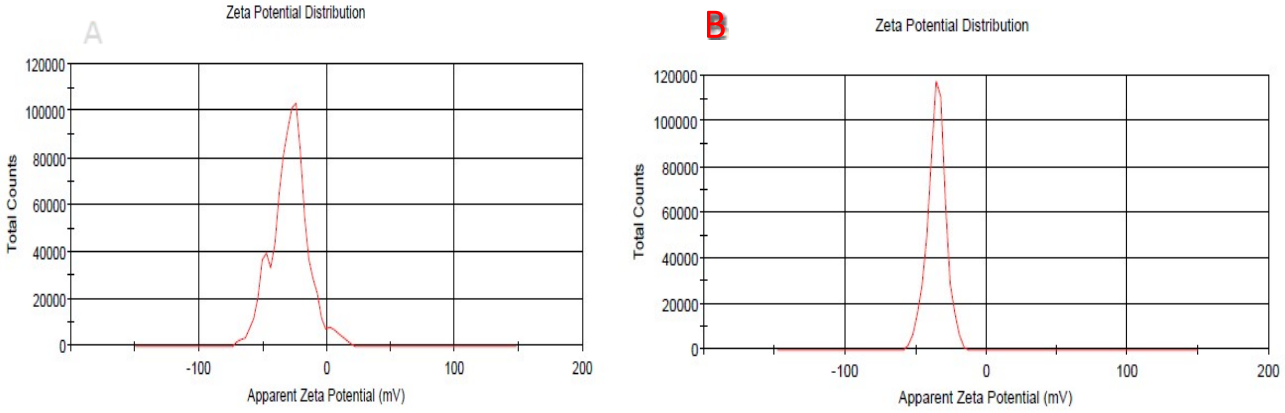



**Fig. S8.** Zeta potential of **(A)** Ag NWs, **(B)** combination of Ag NWs and Hyd (immediately, t = 0s)

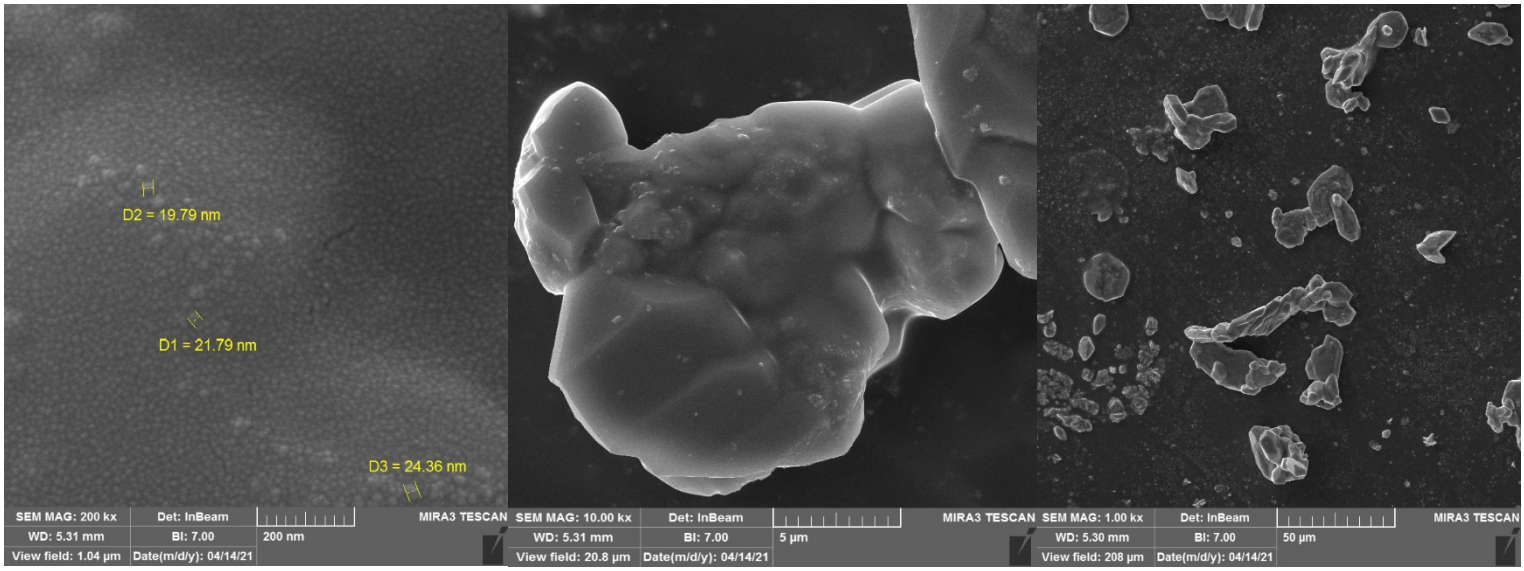



**Fig. S9.** FE-SEM images of Ag NWs in different magnification.

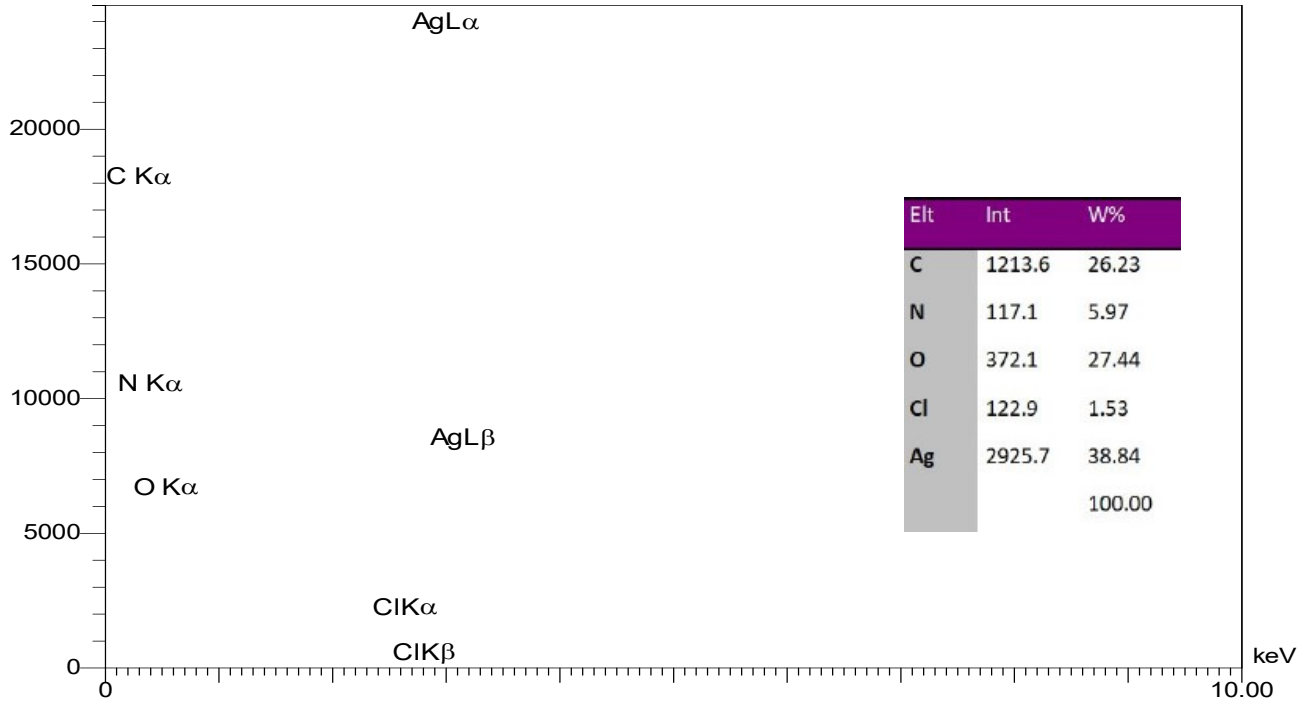



**Fig. S10.** EDS spectra of Ag NWs.

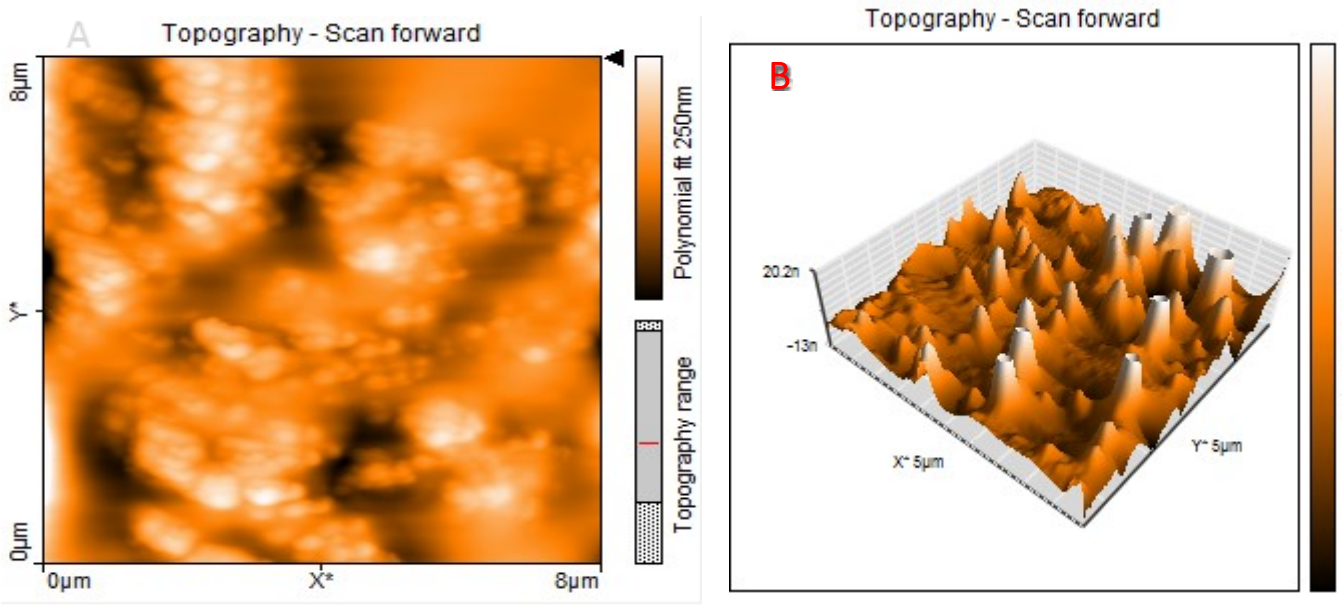



**Fig. S11.** Topographic AFM images in 2D, **(A)** and 3D, **(B)** view of Ag NWs.

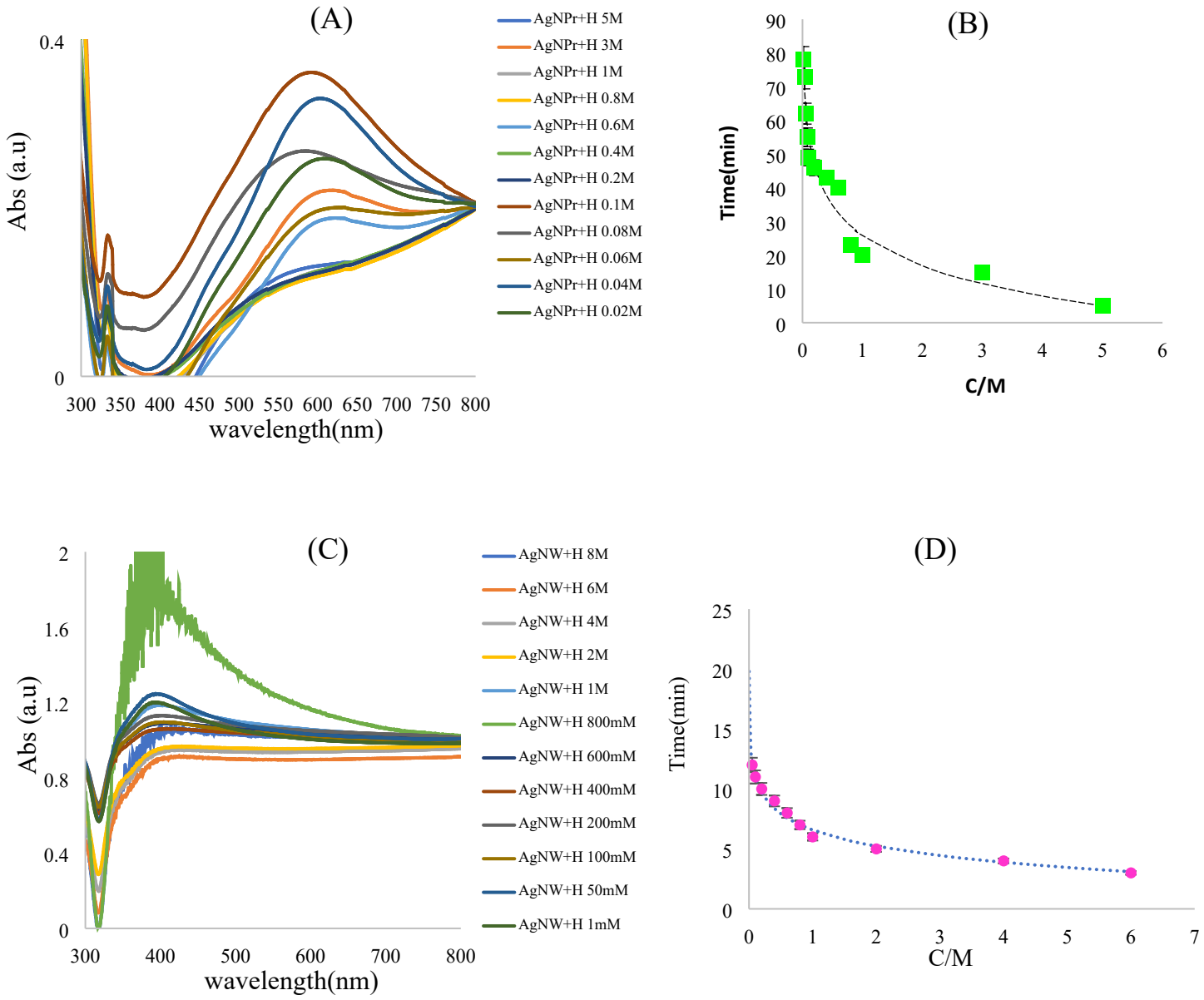
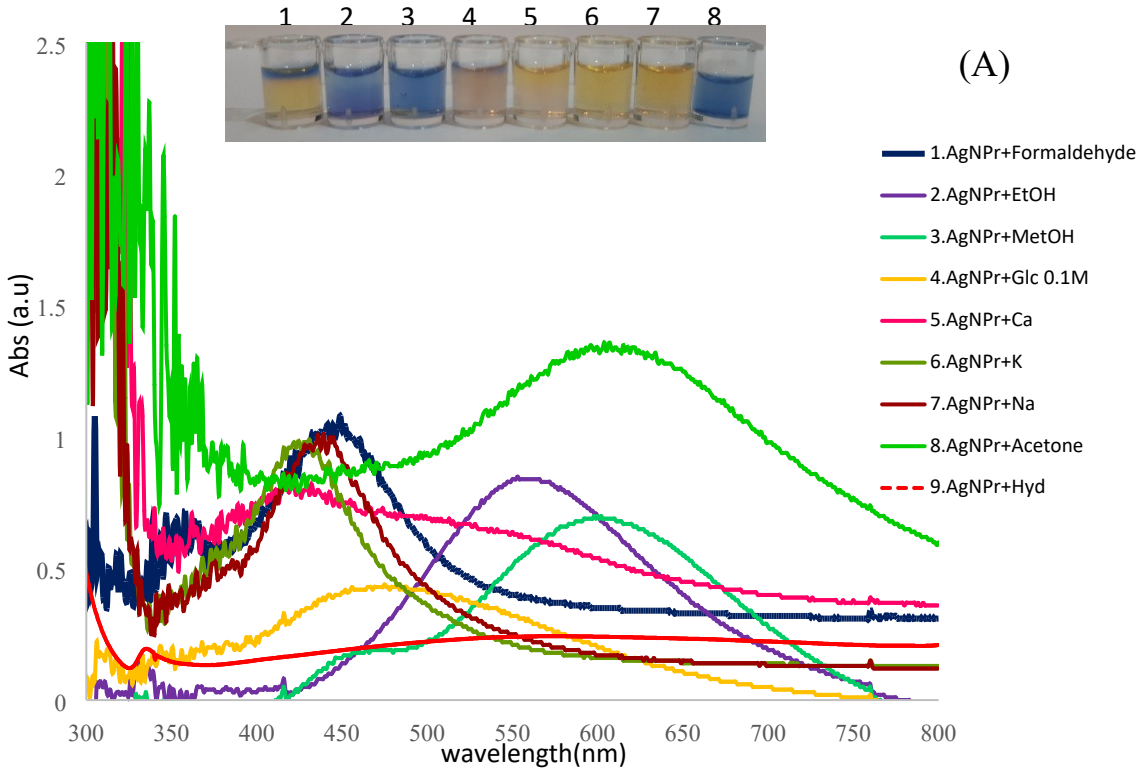
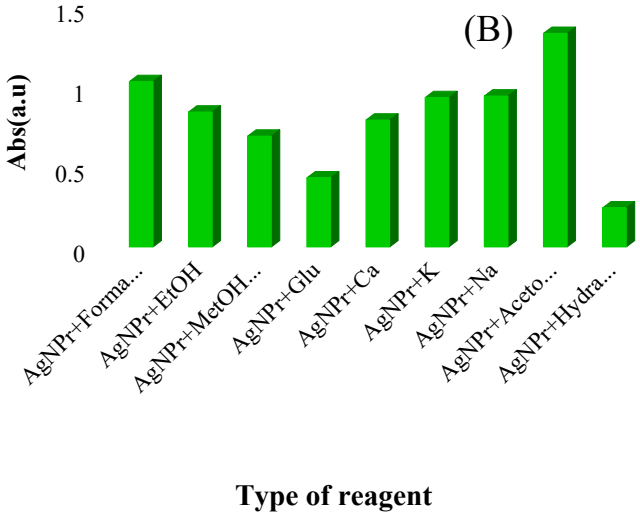
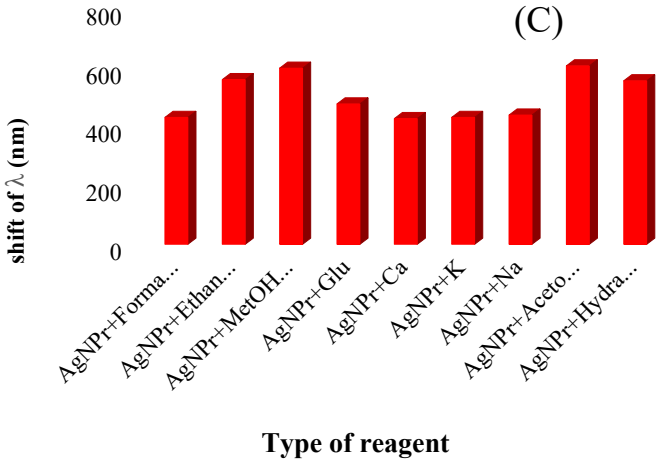


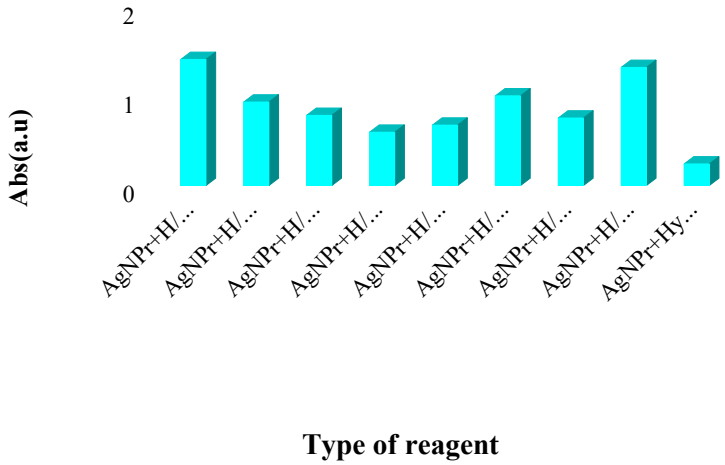

**Fig. S12. A, C)** UV-Vis spectra of different concentrations of Hyd in the presence of optical probes (AgNPrs, AgNWs), respectively. **B, D)** Dependency of reaction time versus different concentrations of Hyd


1 2 3 4 5 6 7 8
(A)
Abs (a.u)
wavelength(nm)
1.AgNPr+Formaldehyde
2.AgNPr+EtOH
3.AgNPr+MetOH
4.AgNPr+Glc 0.1M
5.AgNPr+Ca
6.AgNPr+K
7.AgNPr+Na
8.AgNPr+Acetone
9.AgNPr+Hyd

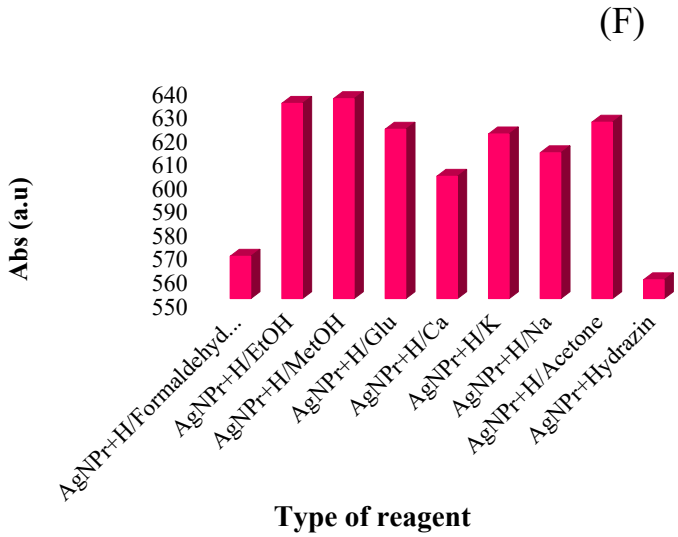

(B)
Abs(a.u)
1.5
1
0.5
0
AgNPr+Forma...
AgNPr+EtOH
AgNPr+MetOH...
AgNPr+Glu
AgNPr+Ca
AgNPr+K
AgNPr+Na
AgNPr+Aceto...
AgNPr+Hydra...
Type of reagent


(C)
shift of λ (nm)
800
600
400
200
0
AgNPr+Forma...
AgNPr+Ethan...
AgNPr+MetOH...
AgNPr+Glu
AgNPr+Ca
AgNPr+K
AgNPr+Na
AgNPr+Aceto...
AgNPr+Hydra...
Type of reagent

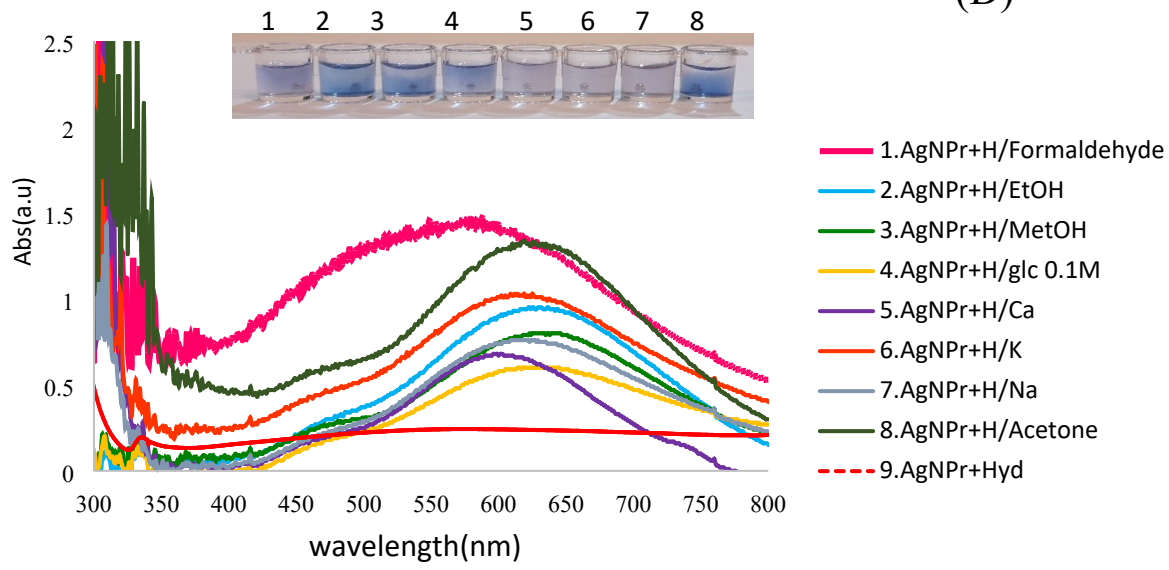
(E)


Abs(a.u)
2
1
0
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+H/...
AgNPr+Hy...
Type of reagent

(F)


Abs (a.u)
640
630
620
610
600
590
580
570
560
550
AgNPr+H/Formaldehyd...
AgNPr+H/EtOH
AgNPr+H/MetOH
AgNPr+H/Glu
AgNPr+H/Ca
AgNPr+H/K
AgNPr+H/Na
AgNPr+H/Acetone
AgNPr+Hydrazin
Type of reagent

(D)


1 2 3 4 5 6 7 8
Abs(a.u)
2.5
2
1.5
1
0.5
0
300 350 400 450 500 550 600 650 700 750 800
wavelength(nm)
1.AgNPr+H/Formaldehyde
2.AgNPr+H/EtOH
3.AgNPr+H/MetOH
4.AgNPr+H/glc 0.1M
5.AgNPr+H/Ca
6.AgNPr+H/K
7.AgNPr+H/Na
8.AgNPr+H/Acetone
9.AgNPr+Hyd

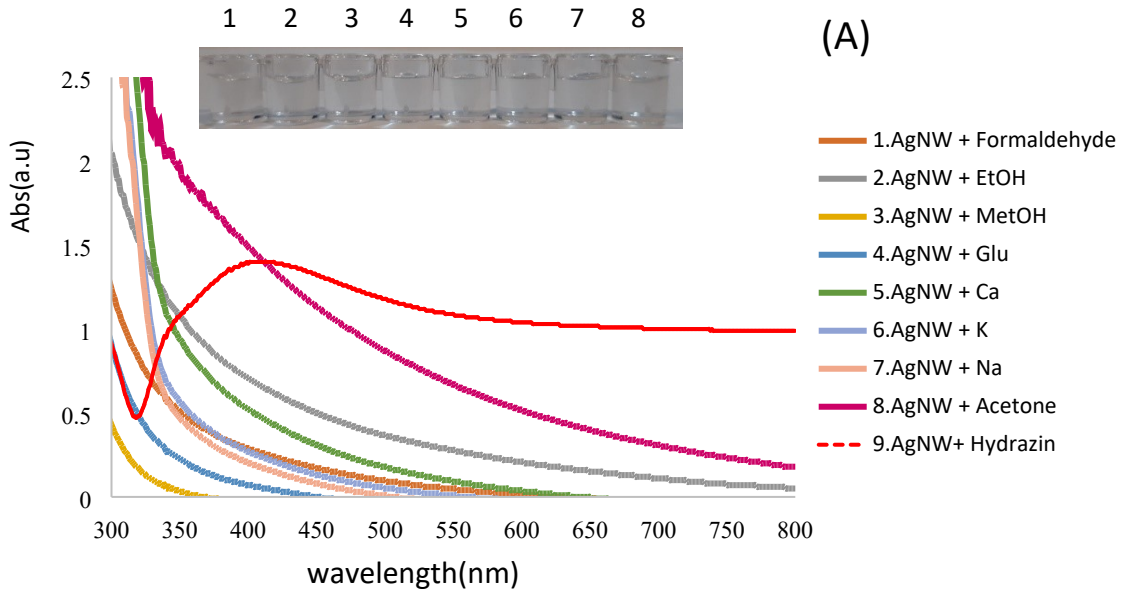



**Fig. S13.** photographic images and spectroscopic UV-Vis graphs of: **A)** AgNPr/Formaldehyde, AgNPr/EtOH, AgNPr/MetOH, AgNPr/Glu, AgNPr/Ca, AgNPr/K, AgNPr/Na, AgNPr/Acetone. **D)** AgNPr/(Formaldehyde+H), AgNPr/(EtOH+H), AgNPr/(MetOH+H), AgNPr/ (Glu+H), AgNPr/(Ca+H), AgNPr/(K+H), AgNPr/(Na+H), AgNPr/(Acetone+H). **B, E)** UV-Vis absorption response versus type of reagents. **C, F)** histogram of wavelength changes versus type of reagents.

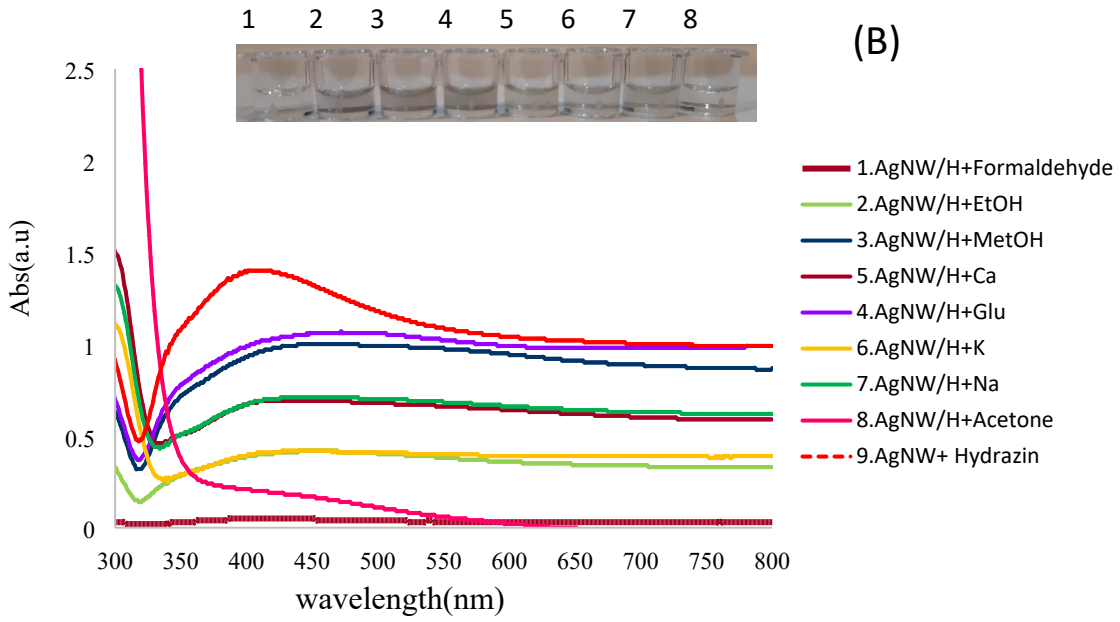


**Fig. S14.** photographic images and Spectroscopic UV-Vis graph of: **A)** AgNWs/Formaldehyde, AgNWs/EtOH, AgNWs/MetOH, AgNWs/Glu, AgNWs/Ca, AgNWs/K, AgNWs/Na, AgNWs/Acetone. **B)** AgNWs/(Formaldehyde+Hyd), AgNWs/(EtOH+ Hyd), AgNWs/(MetOH+ Hyd), AgNWs/(Glu+ Hyd), AgNWs/(Ca+ Hyd), AgNWs/(K+ Hyd), AgNWs/(Na+ Hyd), AgNWs/(Acetone+ Hyd).

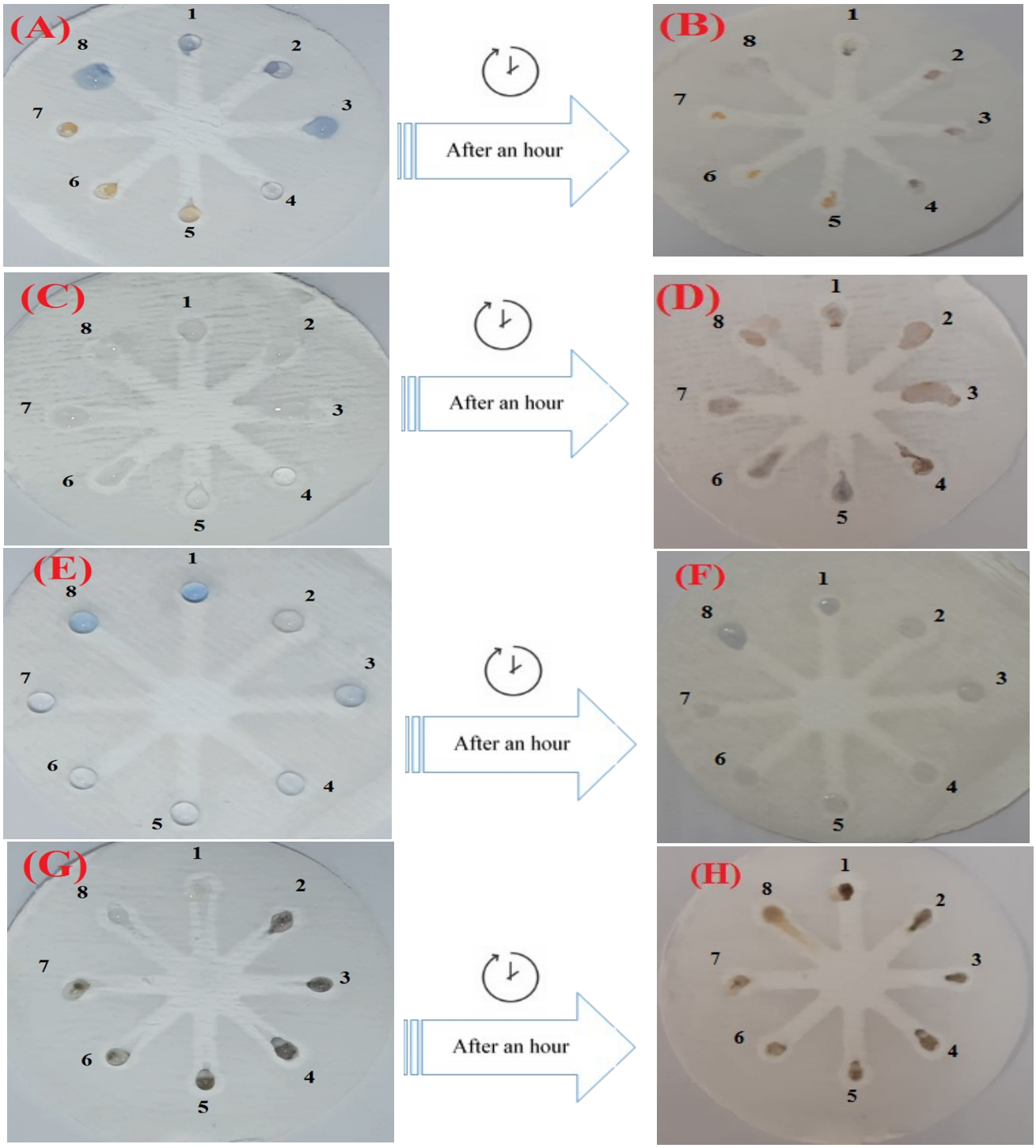
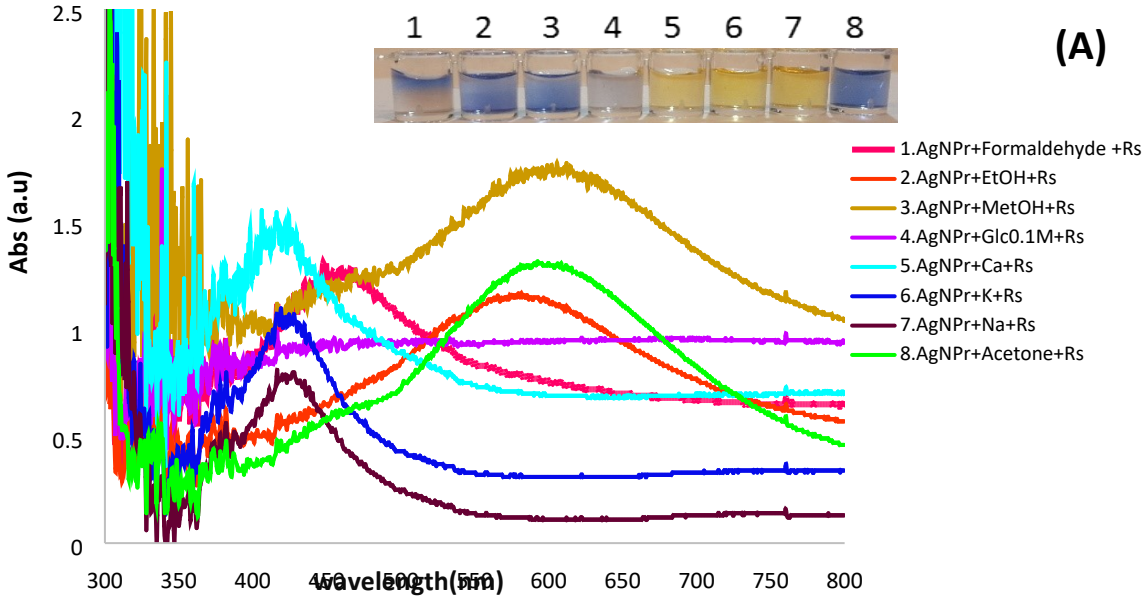
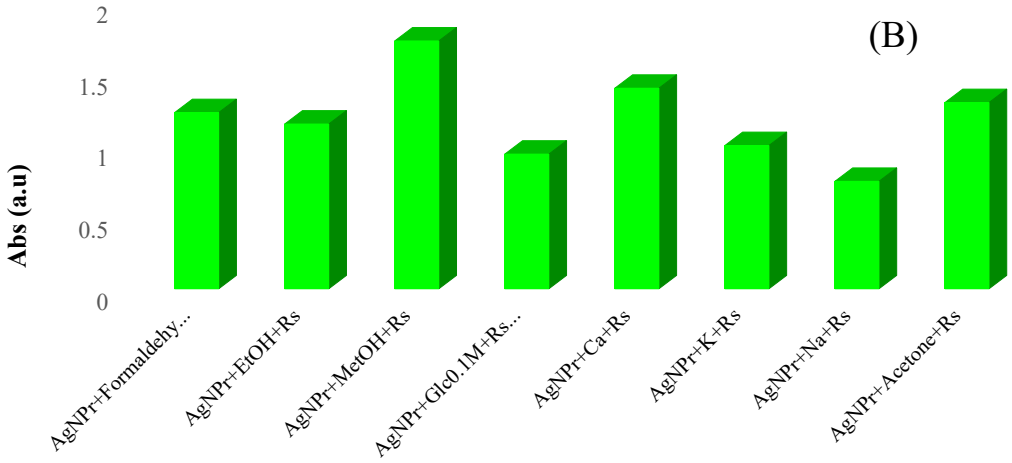
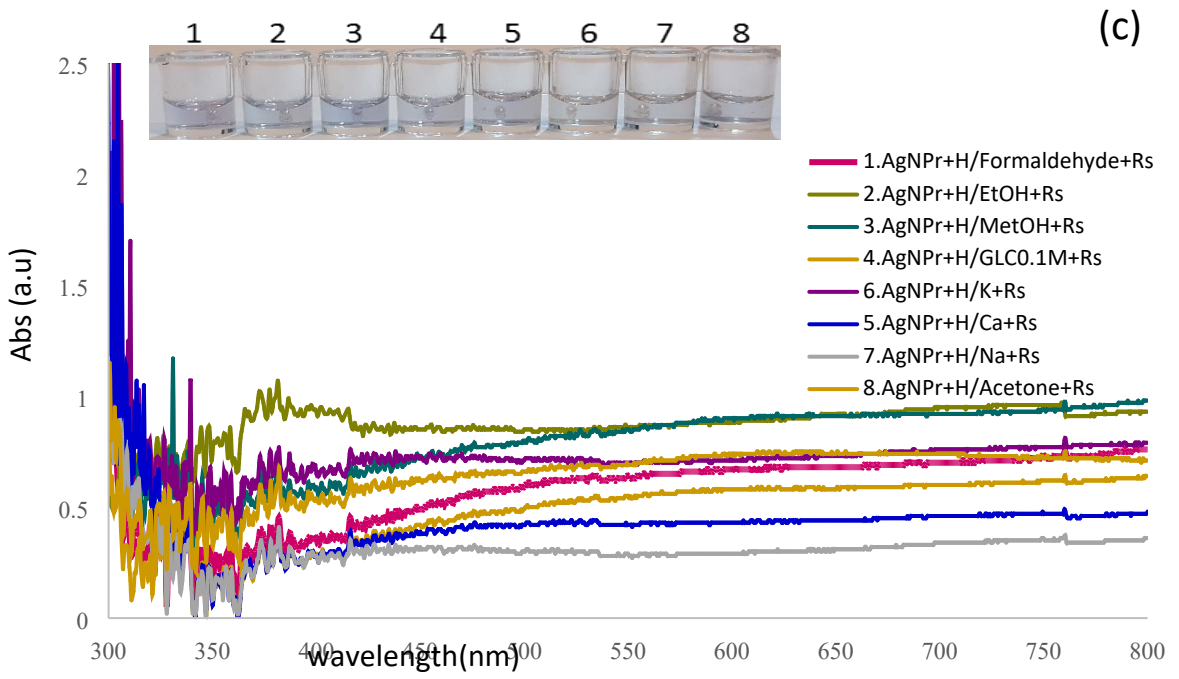
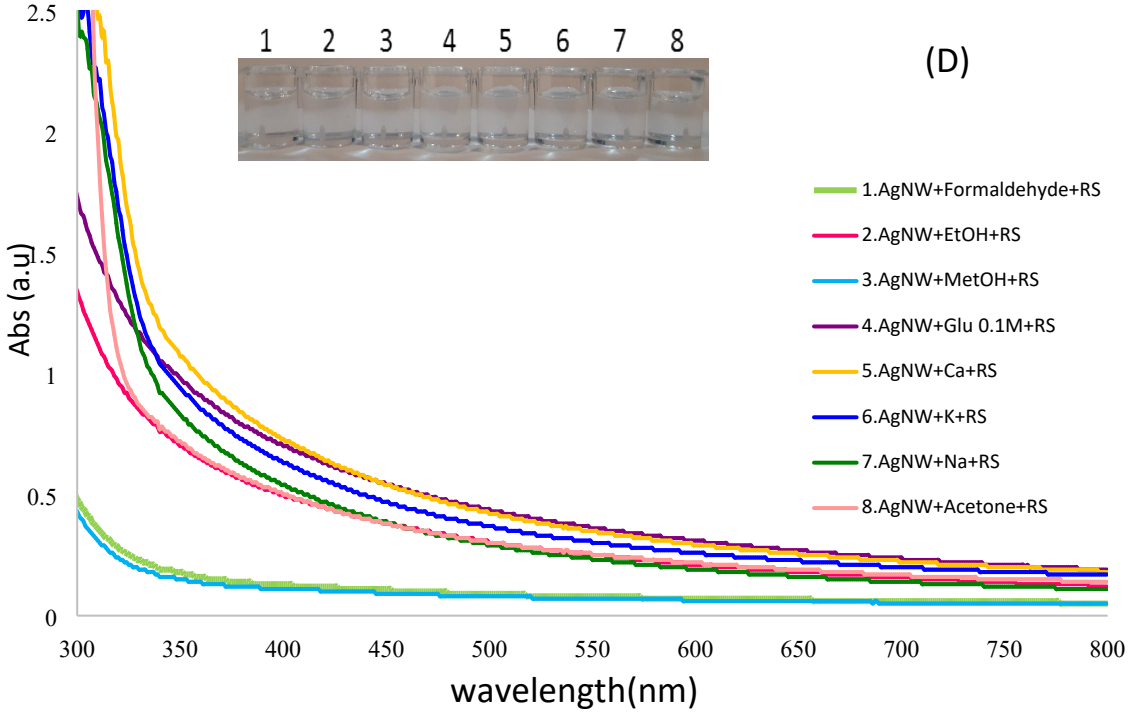



**Fig. S15.** Photographic images of the µPCD-based calorimetric sensor: **A, D)** Interaction between AgNPrs and AgNWs with (Formaldehyde, EtOH, MetOH, Glu, Ca, K, Na, and Acetone) zones 1 to 8, respectively before and after an hour. **C, G)** Interaction between AgNPrs and AgNWs with (Formaldehyde+Hyd, EtOH+Hyd, MetOH+Hyd, Glu+Hyd, Ca+Hyd, K+ Hyd, Na+ Hyd, and Acetone+ Hyd) zones 1 to 8, respectively before and after an hour.


(A)
1 2 3 4 5 6 7 8
Abs (a.u)
2.5
2
1.5
1
0.5
0
300 350 400 450 500 550 600 650 700 750 800
Wavelength(nm)
1.AgNPr+Formaldehyde +Rs
2.AgNPr+EtOH+Rs
3.AgNPr+MetOH+Rs
4.AgNPr+Glc0.1M+Rs
5.AgNPr+Ca+Rs
6.AgNPr+K+Rs
7.AgNPr+Na+Rs
8.AgNPr+Acetone+Rs


(B)
Abs (a.u)
2
1.5
1
0.5
0
AgNPr+Formaldehy...
AgNPr+EtOH+Rs
AgNPr+MetOH+Rs
AgNPr+Glc0.1M+Rs...
AgNPr+Ca+Rs
AgNPr+K+Rs
AgNPr+Na+Rs
AgNPr+Acetone+Rs
Type of interfering species


(c)
1 2 3 4 5 6 7 8
Abs (a.u)
wavelength(nm)
1.AgNPr+H/Formaldehyde+Rs
2.AgNPr+H/EtOH+Rs
3.AgNPr+H/MetOH+Rs
4.AgNPr+H/GLC0.1M+Rs
6.AgNPr+H/K+Rs
5.AgNPr+H/Ca+Rs
7.AgNPr+H/Na+Rs
8.AgNPr+H/Acetone+Rs


(D)
1 2 3 4 5 6 7 8
Abs (a.u)
wavelength(nm)
1.AgNW+Formaldehyde+RS
2.AgNW+EtOH+RS
3.AgNW+MetOH+RS
4.AgNW+Glu 0.1M+RS
5.AgNW+Ca+RS
6.AgNW+K+RS
7.AgNW+Na+RS
8.AgNW+Acetone+RS

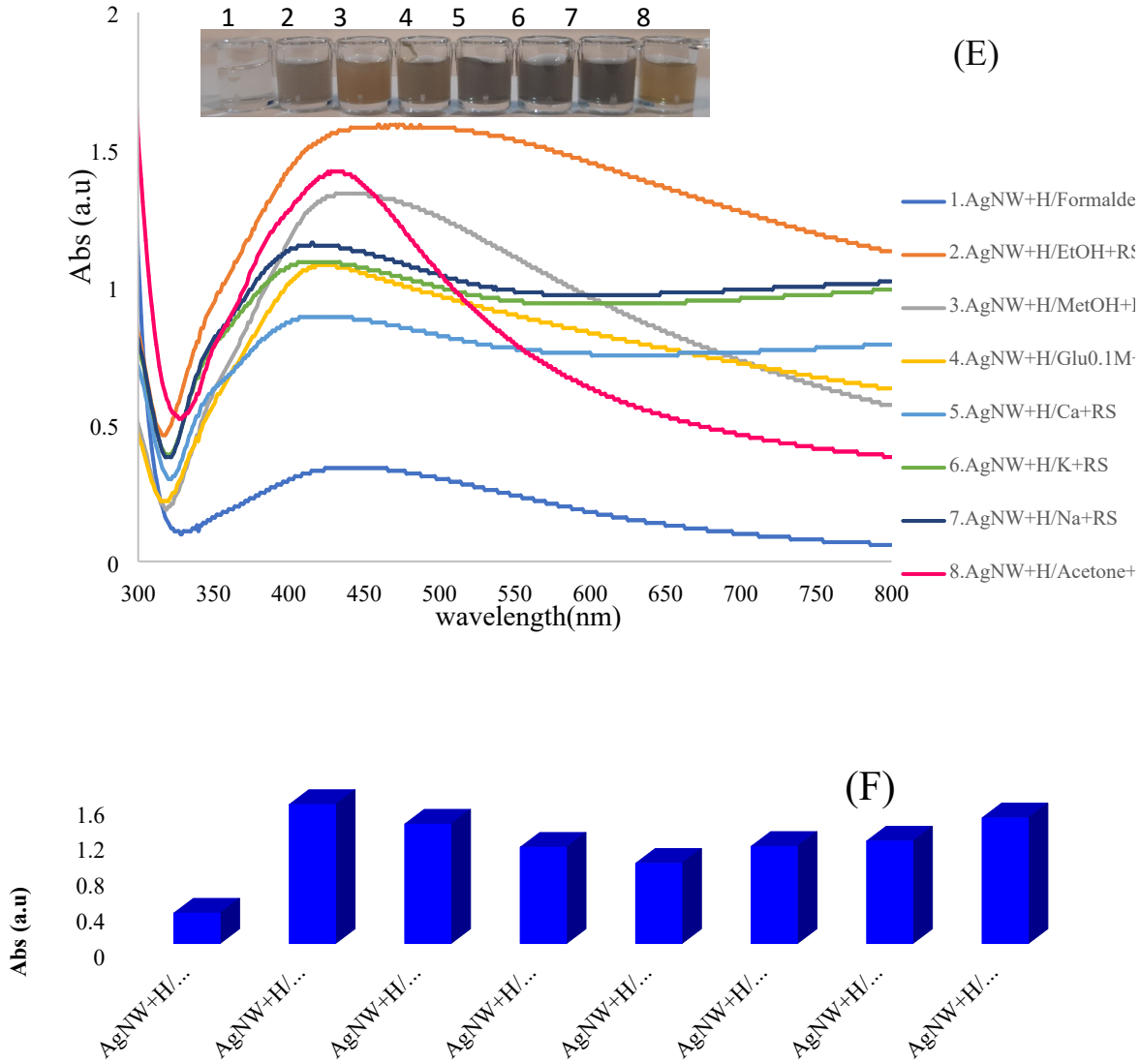
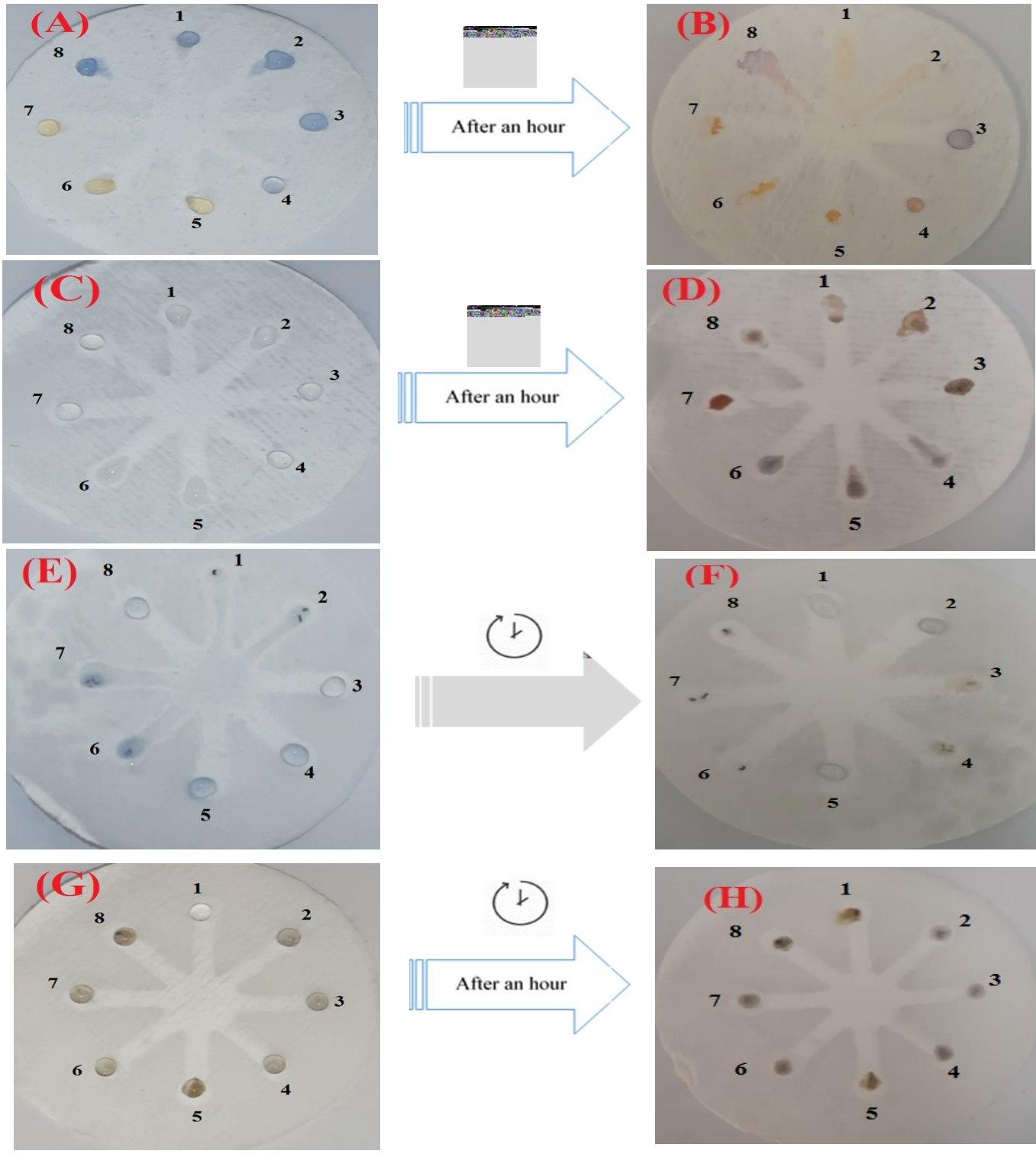



**Fig. S16**. photographic images and spectroscopic UV-Vis graphes of: **A)** AgNPr/Formaldehyde+Rs, AgNPr/EtOH+Rs, AgNPr/MetOH+Rs, AgNPr/Glu+Rs, AgNPr/Ca+Rs, AgNPr/K+Rs, AgNPr/Na+Rs, AgNPr/Acetone+Rs. **C)** AgNPr/(H/Formaldehyde+Rs), AgNPr/(H/EtOH+Rs), AgNPr/(H/MetOH+Rs), AgNPr/(H/Glu+Rs), AgNPr/(H/Ca+Rs), AgNPr/(H/K+Rs), AgNPr/(H/Na+Rs), AgNPr/(H/Acetone+Rs). **D)** AgNWs/Formaldehyde+Rs, AgNWs/EtOH+Rs, AgNWs /MetOH+Rs, AgNWs/Glu+Rs, AgNWs/Ca+Rs, AgNWs/K+Rs, AgNWs/Na+Rs, AgNWs/Acetone+Rs. **E)** AgNWs/(H/Formaldehyde+Rs), AgNWs/(H/EtOH+Rs), AgNWs/(H/MetOH+Rs), AgNWs/(H/Glu+Rs), AgNWs/(H/Ca+Rs), AgNWs/(H/K+Rs), AgNWs/(H/Na+Rs), AgNWs/(H/Acetone+Rs). **B, F)** UV-Vis absorption response versus type of reagents.

**Fig. S17.** Photographic images of the μPCD-based calorimetric sensor: **A, D)** Interaction between AgNPrs and AgNWs with (Formaldehyde/Rs, EtOH/Rs, MetOH/Rs, Glu/Rs, Ca/Rs, K/Rs, Na/Rs, and Acetone/Rs) zones 1 to 8, respectively befor and after an hour. **C, G)** Interaction between AgNPrs and AgNWs with (Formaldehyde/Rs+H, EtOH/Rs+H, MetOH/Rs+ Hyd, Glu/Rs+Hyd, Ca/Rs+ Hyd, K/Rs+ Hyd, Na/Rs+ Hyd, and Acetone/Rs+ Hyd) zones 1 to 8, respectively before and after an hour.


(A)
(B)
(C)
(D)
(E)
(F)
(G)
(H)
After an hour
After an hour
After an hour

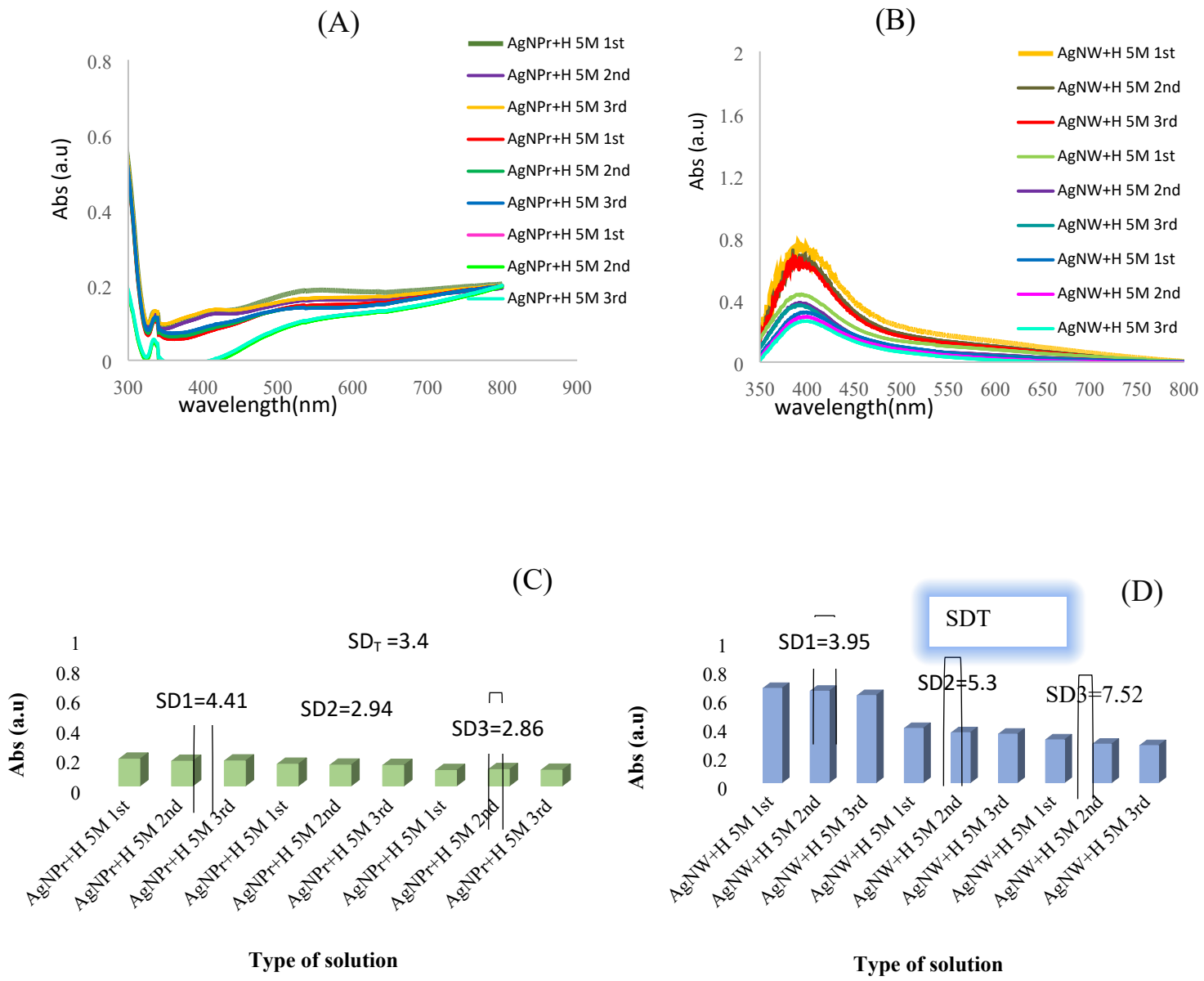



**Fig. S18.** Spectroscopic UV-Vis graphes record of the interaction of: **A)** AgNPrs **B)** AgNWs with 5M Hyd with three repeats, respectively; **C, D)** Histogram of Abs (A.u) *versus* type of solution.

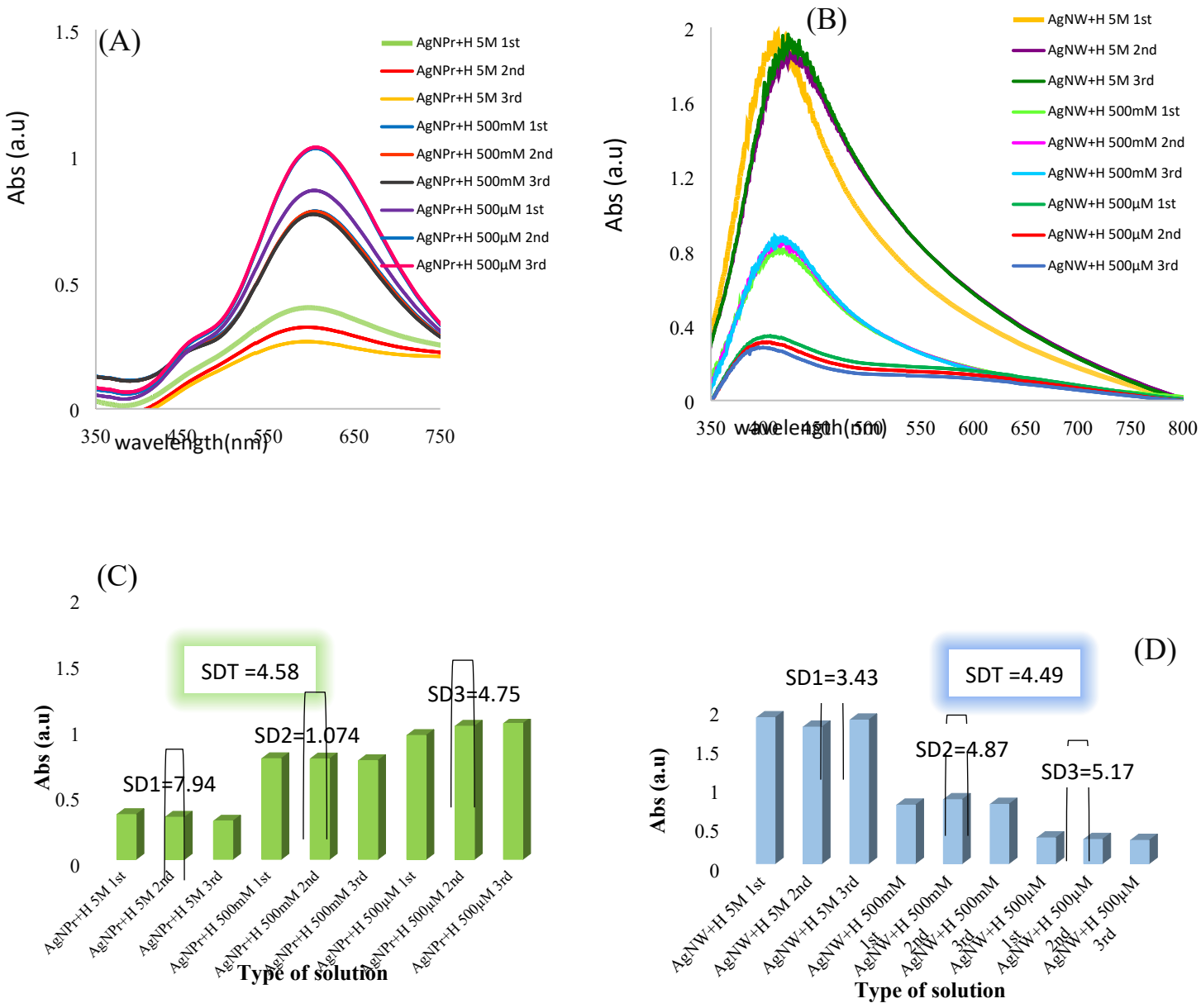



**Fig. S19.** Spectroscopic record of the interaction of: **A)** AgNPrs, **B)** AgNWs with various concentrations of Hyd (5M, 500mM, 500µM); **C, D)** the absorbance of the reaction (A and B) in three repeats at the different concentrations, respectively.

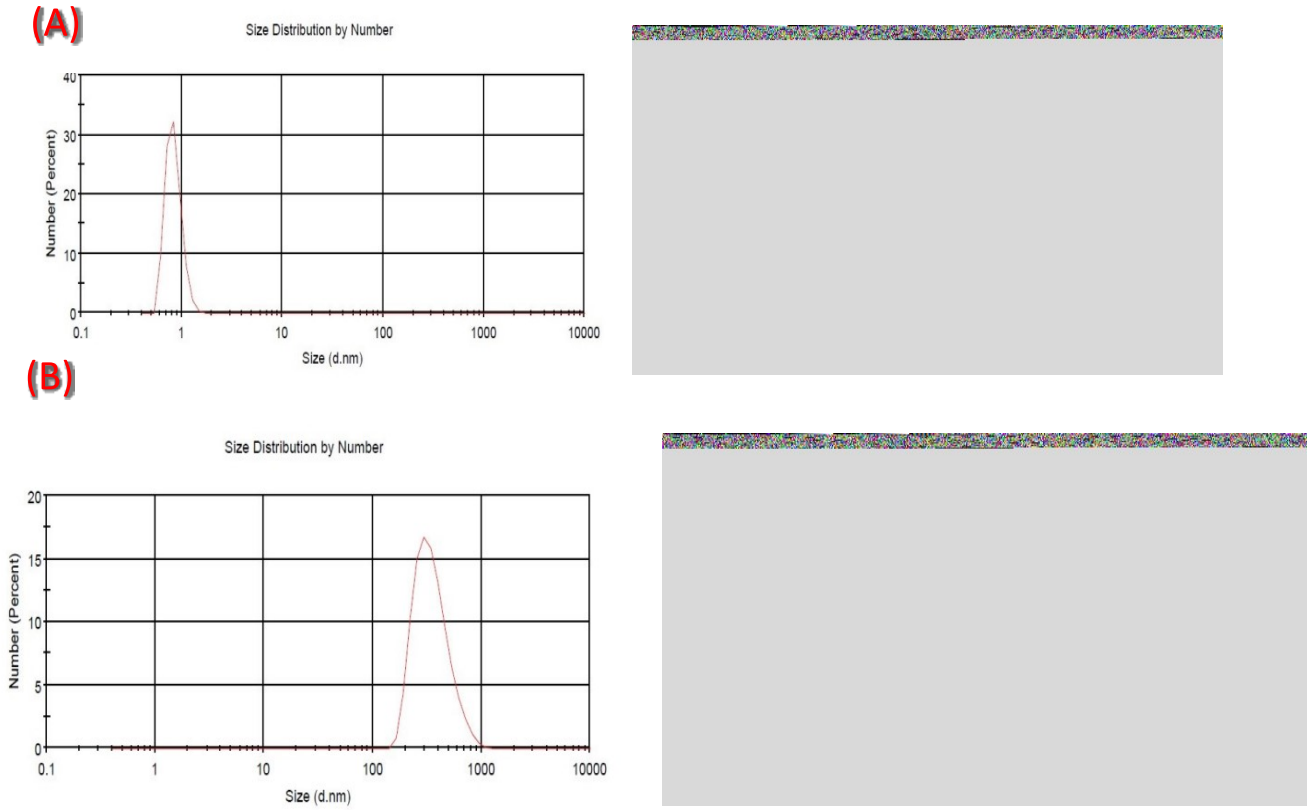



**Fig. S20**. DLS plote of A) Ag NPrs, B) AgNWs before and after 3 month.

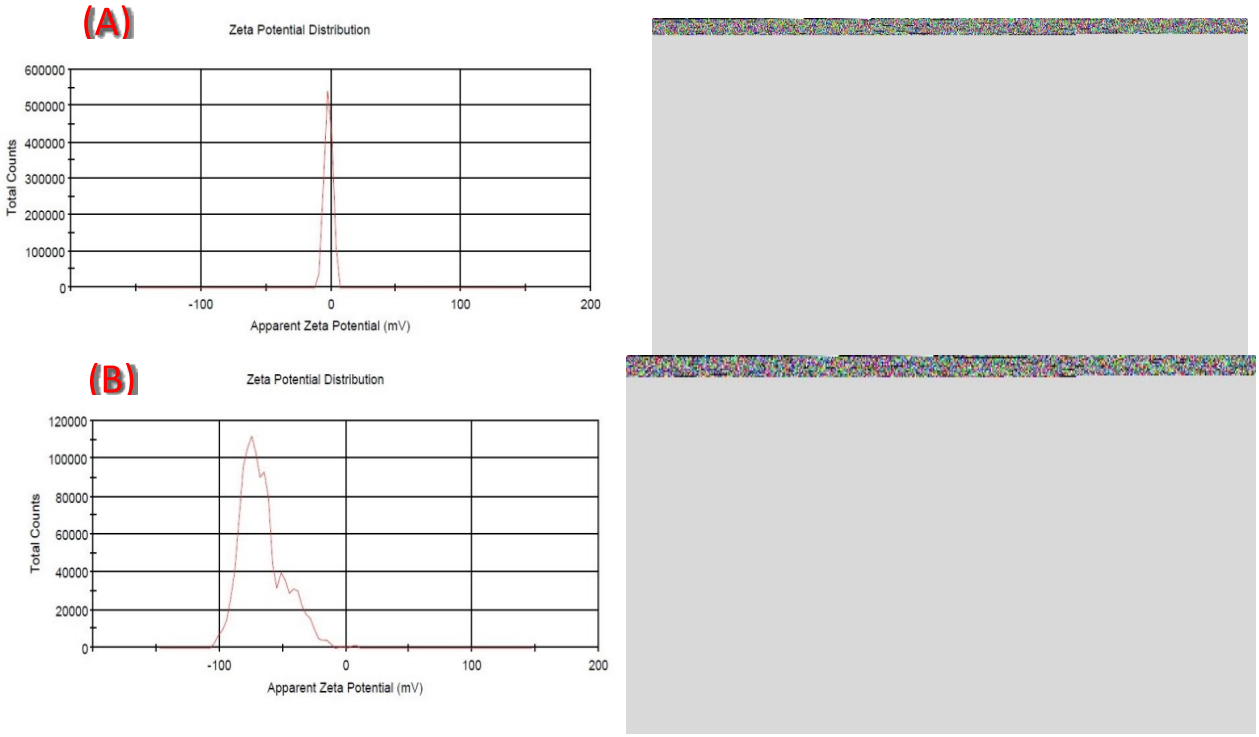


**Fig. S21.** Zeta potential of A) Ag NPrs, B) AgNWs before and after 3 months.

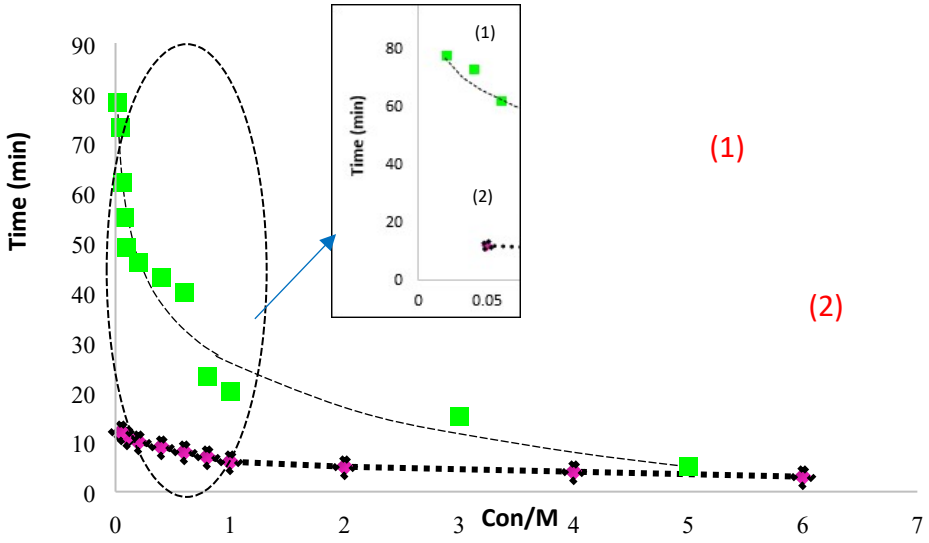



**Fig. S22.** Calibration curve of detection time versus different concentrations of Hyd in the presence of optical probes (1) AgNPrs and (2) AgNWs.