**Electronic Supplementary Information**

**Fig. S1** Approach and mechanism for synthesizing SiO$_2$ capsulized Cu ANPs.

**Fig. S2** (a) Photos of solutions collected in different reaction stages, sample 1: initial solution, sample 2: suspension containing intermediate precipitation, sample 3: suspension containing final Cu ANPs precipitation. (b) UV–vis absorbance spectrum of sample 2.

Fig. S2 a gives photos of solutions collected in different reaction stages. Sample 1 is the initial solution containing CuSO$_4$, PVP and NaH$_2$PO$_4$; sample 2 contains the intermediate precipitation after adding HCl; sample 3 is the final Cu ANPs precipitation. Fig. S2 b gives the UV–vis absorbance spectrum of sample 2. Two absorption bands were observed. The signed peak centered at 485 nm is attributed to Cu$_2$O. The other broad peak raised from 575 nm is concerned to Cu. So, Cu$_2$O and Cu both existed in sample 2. That is, this stage is the transformation stage from Cu$_2$O to Cu.
According to the EDX results, the molar ratios of Cu to Si in the three samples are about 1:0.1075 (Cu₁), 1:0.1748 (Cu₂) and 1:0.7376 (Cu₃) respectively. Comparing to the theoretical ratios of Cu and SiO₂ (1:0.1, 1:0.2 and 1:0.5), we think that most of the feeding SiO₂ was deposited onto Cu nanoparticles. The detected result of Cu₁ is accord with the theoretical ratio (1:0.1). Due to the randomness of selective area in EDX and unevenness of SiO₂ deposition, the detected result of Cu₂ is smaller than the theoretical ratio (1:0.2). While for Cu₃, deposition of SiO₂ got more uneven as the feeding TEOS increased. Thus the detected result shows bigger than the theoretical ratio (1:0.5).
**Fig. S4** SEM image of Cu$_3$. 

**Fig. S5** TG–DTA curve for decomposition of laboratory-prepared AP.
**Fig. S6** DTA curve for decomposition of AP in the presence of SiO$_2$ (AP:SiO$_2$=95:5).