Support Information

Anions-Mediated Synthesis of Monodisperse Silver Nanoparticles and Useful for Screen Printing of High-Conductivity Patterns on Flexible Substrates for Printed Electronics

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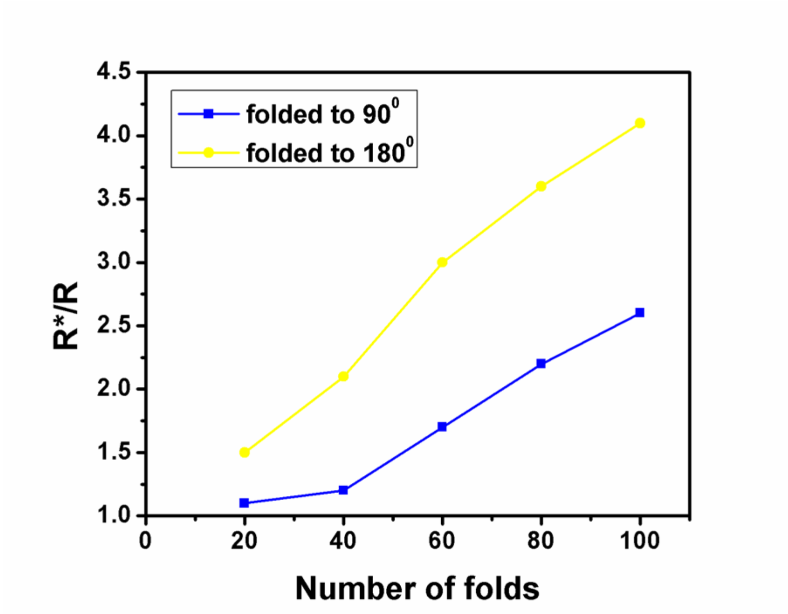

Figure S1 The resistance changing after different bending.

Optimize the concentration of anions.

According to the literature[1-2], we calculated the solubility product constants (Ksp) of different silver compounds and the maximum concentrations of the corresponding anions in water at the $AgNO_3$ concentration used in our work (**Table S1**).

All of the data we used for the following calculations were abstracted from refs 1-2. In summary, the enthalpy of the reaction and Ksp are calculated as follows:

$$\Delta H^{\theta} = \Sigma\Delta H^{\theta}_{resultant} - \Sigma\Delta H^{\theta}_{reactant} \qquad (1)$$

$$\mathrm{Ln}\frac{K_{sp,T_2}}{K_{sp,T_1}} = \frac{\Delta H^{\theta}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad (2)$$

where Ksp is the solubility product constant, T is the temperature, R is the gas constant, and ΔH^{θ} is the standard enthalpy of the reaction, which almost has no relation with temperature. In our case, ΔH^{θ} is used as the constant (**Table S2**) for calculation ($\Delta H^{\theta} \approx \Delta H^{\theta}_{298\ K}$). For example, the ΔH^{θ} and Ksp value of the Ag_2SO_4 compound at 25 °C is 17.8 kJ mol^{-1} and 1.20×10^{-5}. Therefore, the Ksp value of Ag_2SO_4 at

60 °C can be calculated to be 2.55×10^{-5} easily via using the formula (2). While the same calculation procedures are applied to obtain the Ksp values of other silver compounds (**Table S2**) except for Ag_3PO_4.

So far, there is no available data for the standard enthalpy(ΔH^{θ}/ kJ mol−1) of the Ag_3PO_4 compound. Thus, the Ksp value need to be calculated by the corresponding standard Gibbs free energy (ΔG^{θ}/kJ mol^{-1}) of Ag^+ and PO_4^{3-} ions and the Ag_3PO_4 compound as follow:

$$\Delta G^{\theta} = 3\Delta G^{\theta}_{Ag^+} + \Delta G^{\theta}_{PO_4^{3-}} - \Delta G^{\theta}_{Ag_3PO_4} \quad (3)$$

$$\ln K_{sp} = -\frac{\Delta G^{\theta}}{RT} \quad (4)$$

where Ksp is the solubility product constant, T is the temperature, and R is the gas constant. ΔG^{θ} is the standard Gibbs free energy of the reaction, which varies little with temperature. In our case, ΔG^{θ} is used as the constant for calculation ($\Delta G^{\theta}\approx\Delta G^{\theta}_{298\ K}$). ΔG^{θ} and the Ksp value of Ag_3PO_4 at 25 °C are 91.6 kJ mol^{-1} and 8.89×10^{-17}. Therefore, the Ksp value of the Ag_3PO_4 compound at 60 °C is calculated to be 4.3×10^{-15} accordingly.

The maximum concentrations of other anions for the formation of the precipitates of the corresponding silver compounds in $AgNO_3$ solution at 60 °C were also calculated according to the calculated Ksp values of different silver compounds at 60 °C and is listed in **Table S1**. Then the concentrations of anions used were optimized based on the maximum concentrations of anions.

Table Captions

Table S1. Summary of the Ksp Values of Different Silver Compounds at 25 °C and at 60 °C in Water, the Maximum Concentrations of Anions Calculated to Form the Precipitates of the Corresponding Silver Compounds in Water at a $AgNO_3$ Concentration of 0.1 M at 60 °C, and the Optimal Concentrations of the Anions Used in Aqueous Solutions of $AgNO_3$/Glucose Mixtures for the Formation of Monodisperse, Curable Ag NPs.

silver compounds	K_{SP} (25℃)	K_{SP} (60℃)	maximum concentrations of anions (M)	optimal concentrations of anions used (M)
Ag_2SO_4	1.20×10^{-5}	2.55×10^{-5}	2.55×10^{-3}	2×10^{-3}
Ag_2CO_3	8.46×10^{-12}	4.58×10^{-11}	4.58×10^{-9}	7×10^{-4}
Ag_3PO_4	8.89×10^{-17}	4.30×10^{-15}	4.30×10^{-12}	1×10^{-3}
AgBr	5.35×10^{-13}	1.91×10^{-11}	1.91×10^{-10}	2×10^{-3}

Table S2. Standard Enthalpy (ΔH^{θ} (kJ mol^{-1})) of Ag+ Ions, Anions, and the Silver Compound and the Calculated Enthalpy of the Reaction.

reaction	ΔH^{θ} (kJ mol^{-1})			
	Ag^+ ions	anions	silver compounds	reaction
$Ag_2SO_4 = 2Ag^+ + SO_4^{2-}$	105.6	-909.3	-715.9	17.8
$Ag_2CO_3 = 2Ag^+ + CO_3^{2-}$	105.6	-677.1	-505.8	39.9
$AgBr = Ag^+ + Br^-$	105.6	-121.6	-100.4	84.4

References

1. Weast, R. C., *The American Journal of the Medical Sciences* **1969,** *257* (6), 423.

2. Speight, J. G., McGraw-Hill New York: **2005**; Vol. 1.