Supporting Information

Wearable screen-printed SERS array sensor on fire-retardant fiber substrate for on-site environmental emergency monitoring

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Contents

S1. Preparation of silver colloids (AgNPs). The citric-capped AgNPs were prepared as the Lee and Meisel method for comparison [1]. Briefly, 0.018 g $AgNO_3$ was dissolved in 100 mL of ultrapure water and brought to boiling, then 1 mL of 1% trisodium citrate solution was rapidly added. The solution was kept on boiling for approximately 20 min.

S2. Calculation of Enhancement Factor (EF). According to the literature [2,3],

$$EF = (I_{SERS} / I_{Raman}) \times (N_{Raman} / N_{SERS})$$

Where I_{SERS} and I_{Raman} are the intensities of the same band in the SERS and ordinary Raman spectra of the target, respectively. N_{Raman} and N_{SERS} values are the estimated molecule numbers of the solution sample and that absorbed on the screen-printed substrate illuminated by the laser, respectively.

In this work, 3 μL of 1.0×10^{-5} M R6G solution was dropped onto the screen-printed substrate, which left a spot of ca. 2.72 mm in diameter, following the SERS spectra of R6G were recorded, and the band 1359 cm^{-1} was selected to calculate the EF. Since the surface coverage of R6G monolayer on the fire-retardant screen-printed substrate is considered to be $\Gamma_{R6G} = C_{R6G} \times V / S = (1.0 \times 10^{-5}\ M \times 3\ \mu L) / (\pi \times (2.72 / 2)^2\ mm^2) = 5.16 \times 10^{-10}\ mol/cm^2$, it can be reckoned that N_{SERS} has a value of 4.05×10^{-14} mol [$N_{SERS} = \Gamma_{R6G} \times \pi \times (10 / 2)^2\ \mu m^2 = 4.05 \times 10^{-14}$ mol], considering the sampling area under laser illumination (ca. 10 μm in diameter).

For the solution sample, 5 μL of 6.06 M R6G solution was pipetted on silicon wafer, which left a spot of ca. 3.00 mm in diameter. Therefore, N_{Raman} has a value of 3.36×10^{-8} mol [$N_{Raman} = (6.06\ M \times 5\ \mu L) / (\pi \times (3.00 / 2)^2\ mm^2) \times \pi \times (10 / 2)^2\ \mu m^2 = 3.36 \times 10^{-8}$ mol].

Raman intensity I_{SERS} is 64526 cnts at the band of 1359 cm^{-1}, and the I_{Raman} is measured to be 311 cnts. Therefore,

$EF_{R6G} = (I_{SERS} / I_{Raman}) \times (N_{Raman} / N_{SERS}) = (64526\ cnts / 311\ cnts) \times (3.36 \times 10^{-8}\ mol / 4.05 \times 10^{-14}\ mol) = 1.71 \times 10^8$.

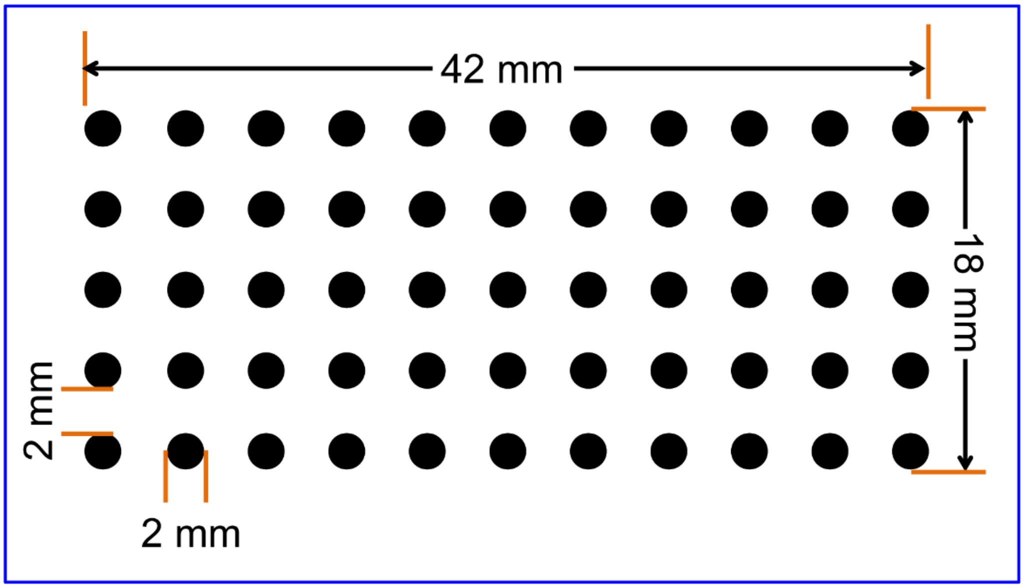


Fig. S1 The design diagram of the wearable fire-retardant screen-printed SERS arrays with the diameter of 2 mm for each spot.

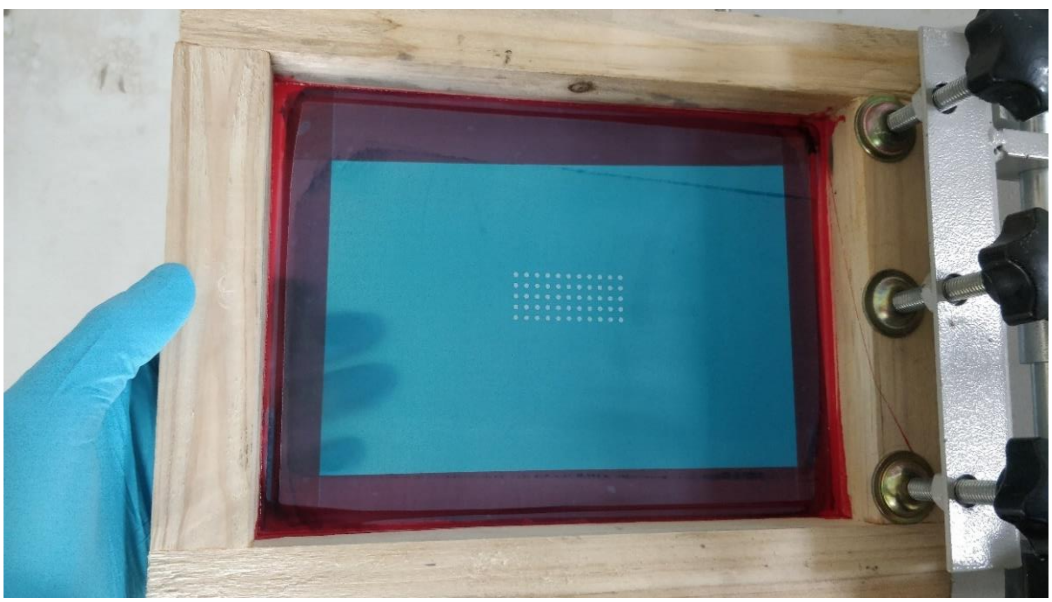


Fig. S2 Photograph of screen-printed stencil with the designed arrays.

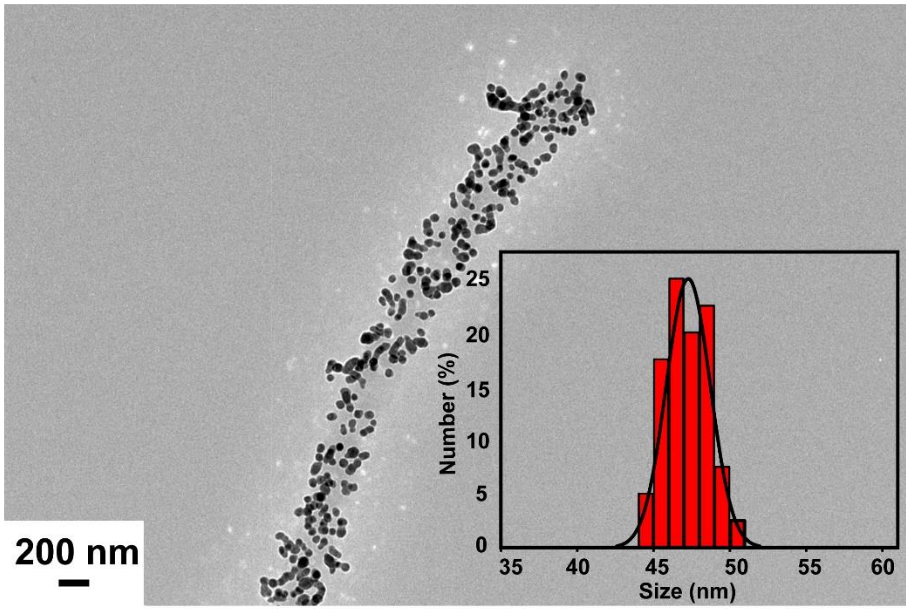


Fig. S3 Representative HRTEM image of Ag/MoS_2 nanocomposites, and the corresponding size distribution.

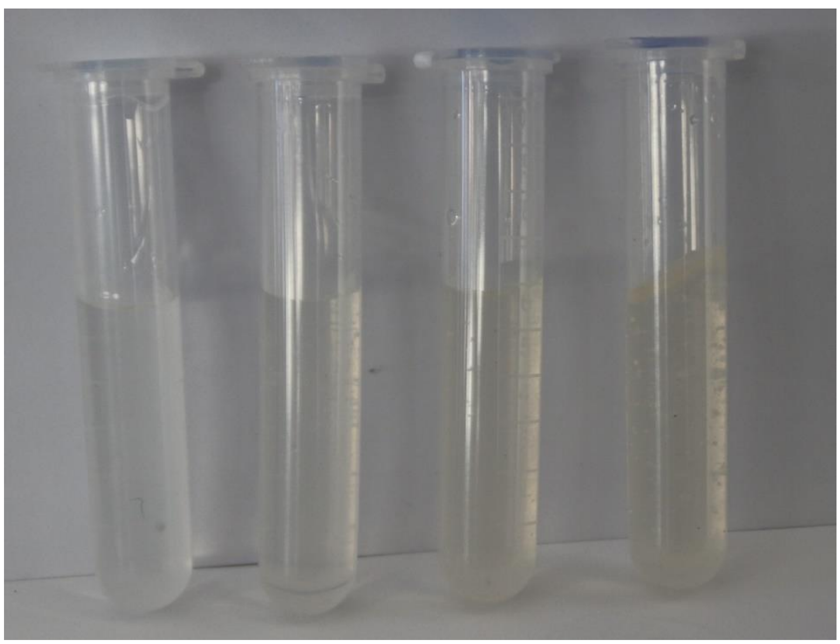


Fig. S4 Photographs of PAC solution with the concentration of 0.5 wt%, 1 wt%, 2 wt% and 3 wt% (from left to right).

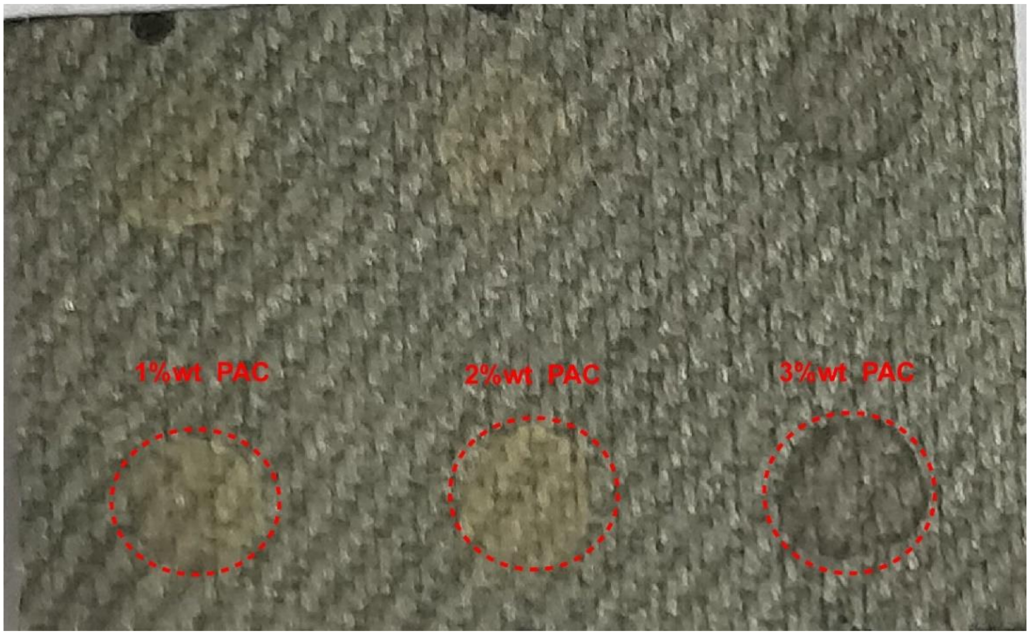


Fig. S5 The magnified photograph of screen-printed SERS arrays on fire-retardant fiber substrate using Ag/MoS_2 ink mixed with 1 wt%, 2 wt% and 3 wt% of PAC solution.

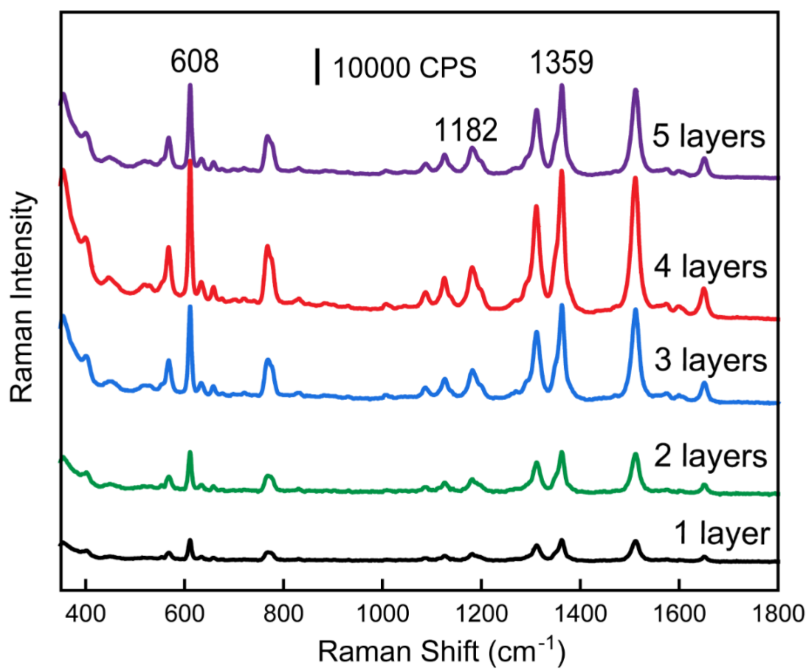


Fig. S6 SERS spectra of 10^{-5} M R6G detected using the screen-printed SERS on fire-retardant fiber glove with different printing layers.

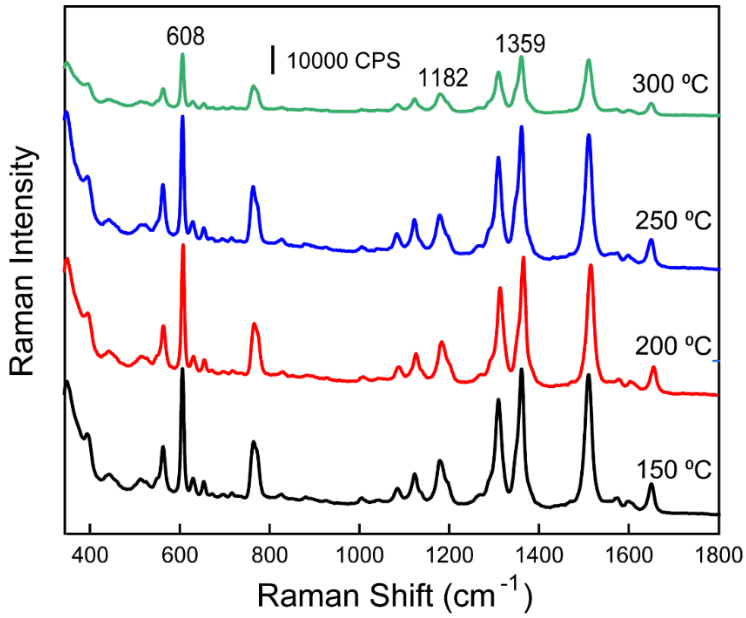


Fig. S7 SERS spectra of 10^{-5} M R6G detected using screen-printed SERS array sensor on fire-retardant fiber glove under different temperature for 10 min.

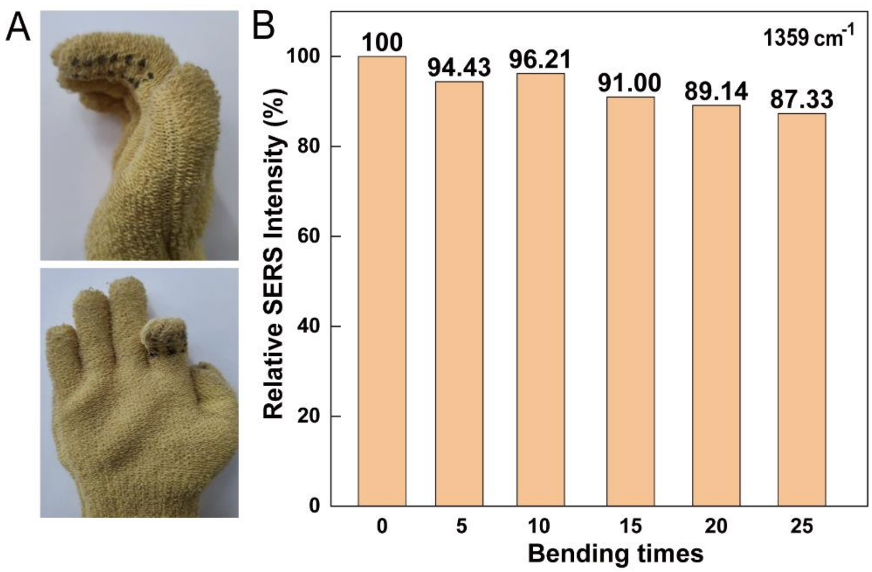


Fig. S8 (A) The photos of fire-retardant fibre gloves under bending states. (B) The relative SERS intensity percentage of the band 1359 cm^{-1} for 10^{-5} M R6G detected using wearable screen-printed SERS array printed on fire-retardant fibre gloves under different bending times.

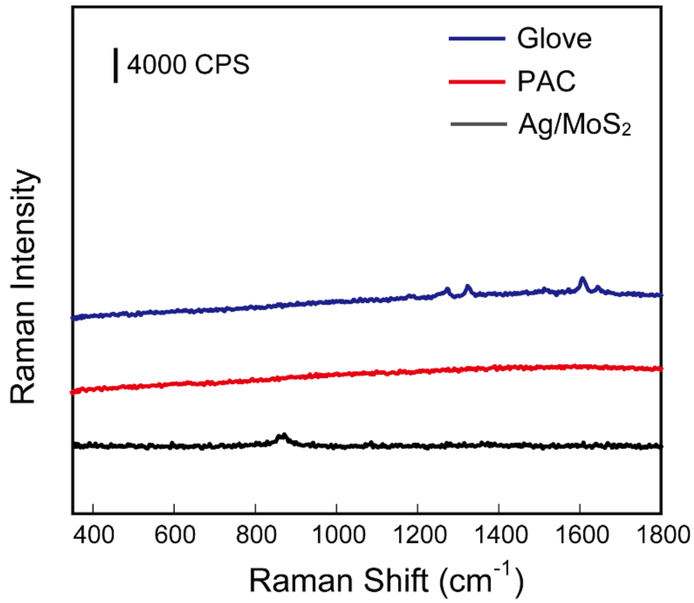


Fig. S9 SERS spectra of the fire-retardant fibre glove, PAC solution and Ag/MoS_2 colloid under 785 nm excitation.

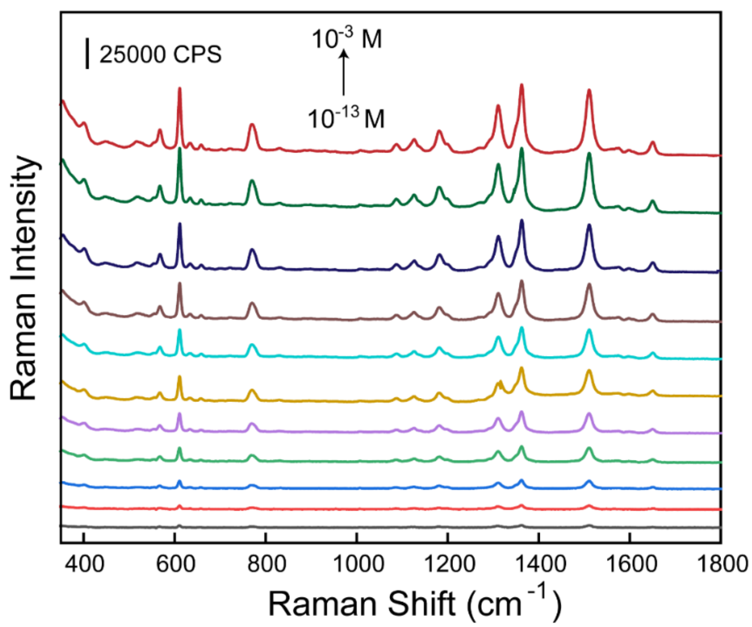
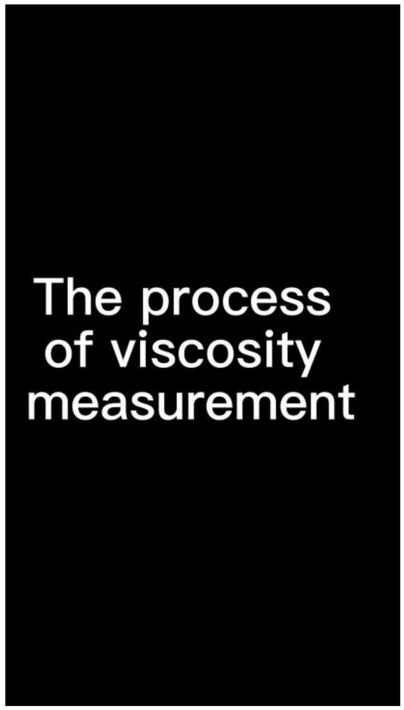


Fig. S10 SERS spectra of different concentrations for R6G detected using screen-printed SERS array sensor on fire-retardant fiber glove.



Video. S1 The kinematic viscosity video detected used a SYD-256B kinematic viscosity tester with the screen-printing ink composed of Ag/MoS_2 colloid added 3 wt% PAC (4:1, v:v).

Table S1. Raman and SERS spectral data of naphthalene, anthracene, and pyrene incubated in wearable SERS array sensor [4-7].

Naphthalene		Anthracene		Pyrene		Assignments
Raman (cm^{-1})	SERS (cm^{-1})	Raman (cm^{-1})	SERS (cm^{-1})	Raman (cm^{-1})	SERS (cm^{-1})	
-	-	392	387	-	-	$\nu_{C\text{-}C\text{-}C\text{-}C}$
-	-	-	-	408	401	$\nu_{C\text{-}C\text{-}C\text{-}C}$
-	-	-	-	457	-	$\nu_{C\text{-}C\text{-}C\text{-}C}$
-	-	-	-	503	-	$\nu_{C\text{-}C\text{-}C\text{-}C}$
509	508	-	-	-	-	$\alpha_{C\text{-}C\text{-}C}$
-	-	-	-	592	609	$\nu_{C\text{-}C\text{-}C\text{-}C}$
-	-	753	750	-	-	$\nu_{C\text{-}C}$
761	755	-	-	-	-	$\gamma_{C\text{-}H}$
1020	1018	1008	1020	-	-	$\nu_{C\text{-}C}$
-	-	-	-	1066	1083	$\delta_{C\text{-}H}$
1146	1158	-	-			$\beta_{C\text{-}H}$; $\tau_{C\text{-}C\text{-}C\text{-}H}$
-	-	1188	-			$\nu_{C\text{-}C}$
-	-	-	-	1144	1174	$\delta_{C\text{-}H}$
-	-	1262	1294	-	-	$\tau_{C\text{-}C\text{-}C\text{-}H}$
-	-	-	-	1241	1307	$\nu_{C\text{-}C}$; $\delta_{C\text{-}H}$
1382	1375	1403	1375	1408	1403	$\nu_{C\text{-}C}$; $\tau_{C\text{-}C\text{-}C\text{-}H}$
1464	-	1482	-	-	-	$\nu_{C\text{-}C}$; $\beta_{C\text{-}C}$
1577	1562	1560	1560	1596	1568	$\nu_{C\text{-}C}$
1629	1609	-	-	1629	1616	$\nu_{C\text{-}C}$

ν **:** stretching; γ: out-of-plane bending; β: in-plane bending; δ: scissoring

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