Electronic Supplementary Information

Hybrid nanomaterials of WS$_2$ or MoS$_2$ nanosheets with liposomes: biointerfaces and multiplexed drug delivery

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Additional experimental methods

**Atomic force microscopy (AFM) and Raman spectroscopy.** For AFM analysis, a WS$_2$ suspension (200 µg/mL) was spun coated onto a freshly cleaved mica substrate. AFM measurements were performed with a Nanoscope MultiMode™ AFM instrument (Veeco) in the tapping mode. The height profile was obtained using Gwyddion software. Raman spectra were collected using a Horiba HR800 spectrometer operating at $\lambda = 532$ nm.

**Flow cytometry.** HeLa cells were seeded in 24-well plates at around 100 000 cells per well in 500 µL of DMEM/F12 cell culture medium and incubated at 37 °C in 5% CO$_2$ humidified atmosphere for 24 h. The medium was then replaced with fresh medium, and WS$_2$/CF-DOPC or WS$_2$/DOX/CF-DOPC was added with a final WS$_2$ concentration of 20 µg mL$^{-1}$ and DOPC concentration of 20 µg mL$^{-1}$. For the control sample, the cells were incubated with the cell culture medium only. After 1 h incubation, the cells were washed with PBS buffer 3 times, harvested, and suspended in 250 µL of 0.5 % formaldehyde for analyses using a FACSArray Fusion flow cytometer. The data were analyzed using BD Facsdiva software.
Figure S1. (a) An AFM micrograph and (b) its height profile our WS₂ nanosheets.

Figure S2. A Raman spectrum of MoS₂. The strong Raman peaks at 381.7 cm⁻¹ and 406.2 cm⁻¹ are corresponding to the in-plane E₁²g and out-of-plane A₁g of lithium borohydride (LiBH₄) exfoliated MoS₂.¹
Figure S3. Colloidal stability test of WS$_2$DOX and WS$_2$DOX/DOPC in the cell culture medium by (a) centrifugation and (b) without centrifugation. The observed red color was due to the cell culture medium and DOX. Both WS$_2$DOX and WS$_2$DOX/DOPC in the cell culture medium were transparent after a gentle bath sonication. However, after centrifugation at 3000 rpm for 2 min, a large amount of precipitant was observed for WS$_2$DOX while WS$_2$DOX/DOPC remained stable. This indicated that the colloidal stability of WS$_2$DOX increased with adsorption of DOPC liposomes. The increased stability was also illustrated when WS$_2$DOX and WS$_2$DOX/DOPC were left at room temperature without centrifugation. After sitting for 30 min, small aggregates were observed for WS$_2$DOX. After 2 h, large aggregates formed. While the WS$_2$DOX/DOPC sample remained transparent up to 2 h.
**Figure S4.** Flow cytometry histograms of the control (untreated HeLa cells), and WS$_2$/CF-DOPC and WS$_2$DOX/CF-DOPC treated HeLa cells. (a) The green CF channel and (b) the red DOX channel. The increased green fluorescence in (a) has indicated the uptake of the hybrid material, consistent with the confocal fluorescence microscopy results. In (b), the WS$_2$/CF-DOPC sample did not have any red dye and thus it showed no shift in the red channel, while the DOX containing sample was strongly fluorescent due to uptake of DOX.

**Additional references**