Electronic supplementary information (ESI)

for

Aggregation of layered double hydroxide nanoparticles in the presence of heparin: Towards highly stable delivery systems

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Conversion of the electrophoretic mobility data

The electrophoretic mobility (u) was measured with a ZetaNano ZS (Malvern) device. The electrokinetic potential (ζ) was calculated from these data using Smoluchowski's equation[1] as shown below:

$$\zeta = \frac{u\eta}{\varepsilon\varepsilon_0} \qquad \text{* MERGEFORMAT (S1)}$$

where η is the viscosity of water, ε_0 is the permittivity of vacuum and ε is the dielectric constant. The surface charge density (σ) was determined by fitting ζ at different ionic strengths with the Debye-Hückel charge-potential relationship[1] as follows:

$$\sigma = \varepsilon\varepsilon_0\kappa\zeta \qquad \text{* MERGEFORMAT (S2)}$$

where κ is the inverse Debye length[1] which contains the contribution of all ionic species and can be defined as:

$$\kappa = \sqrt{\frac{2N_A e^2 I}{\varepsilon\varepsilon_0 k_B T}} \qquad \text{* MERGEFORMAT (S3)}$$

where N_A is the Avogadro number, e is the elementary charge, I is the ionic strength, k_B is the Boltzmann constant and T is the absolute temperature.

Principles of dynamic light scattering (DLS)

The hydrodynamic radius (R_h) of the LDH particles was measured with DLS using a compact goniometer system (ALV/CGS-3) at 90° scattering angle. The correlation function ($g^1(\tau)$) was accumulated for 20 seconds and a second cumulant fit was used:[2]

$$\ln[g^1(\tau)] = \ln B - \overline{\Gamma}\tau + \frac{\mu_2 \tau^2}{2} \qquad \text{* MERGEFORMAT (S4)}$$

where $\overline{\Gamma}$ is the average decay constant, B is the baseline originating from the scattering setup, τ is the delay time of the correlation and μ_2 is the second cumulant variance which can be used to calculate the polydispersity index (PDI) of the sample:

$$PDI = \frac{\mu_2}{\overline{\Gamma}^2} \qquad \text{* MERGEFORMAT (S5)}$$

The translational diffusion coefficient (D) of the particles, which undergo Brownian motion, is related to $\overline{\Gamma}$ in the following equation:

$$D = \frac{q^2}{\overline{\Gamma}} \qquad \text{* MERGEFORMAT (S6)}$$

where q is the magnitude of the scattering vector. Finally, R_h can be then calculated with the Stokes-Einstein equation:

$$R_h = \frac{k_B T}{6\pi\eta D} \qquad \text{* MERGEFORMAT (S7)}$$

The R_h measured for the platelet-like LDH particles is equal to the radius of an equivalent sphere.

Interpretation of X-ray diffraction (XRD) data

Powder XRD patterns of solid LDH samples were recorded on a Stadi-P (Stoe) instrument. The Bragg equation was used to calculate the *d*-spacing values and lattice parameters:[3]

$$n\lambda = 2d\sin\theta_B$$ * MERGEFORMAT (S8)

where n is an integer (in general it is 1), λ is the wavelength of the laser, d is the lattice spacing and θ_B is the Bragg angle. The average thickness of the particles (υ) was calculated using the Scherrer's equation:

$$\upsilon = K\lambda / \beta\cos\theta_B$$ * MERGEFORMAT (S9)

where K is the shape factor (0.89 was used in the calculation) and β is the line broadening at the full widths at half maximum in radian obtained by applying Gaussian fits to the peaks.

References

1 D. F. Evans and H. Wennerstrom, *The Colloidal Domain*, John Wiley, New York, 1999.

2 P. A. Hassan, S. Rana and G. Verma, *Langmuir,* 2015, **31**, 3-12.

3 D. G. Evans and R. C. T. Slade In *Layered Double Hydroxides*; X. Duanand D. G. Evans, Eds. 2006; Vol. 119, p 1-87.

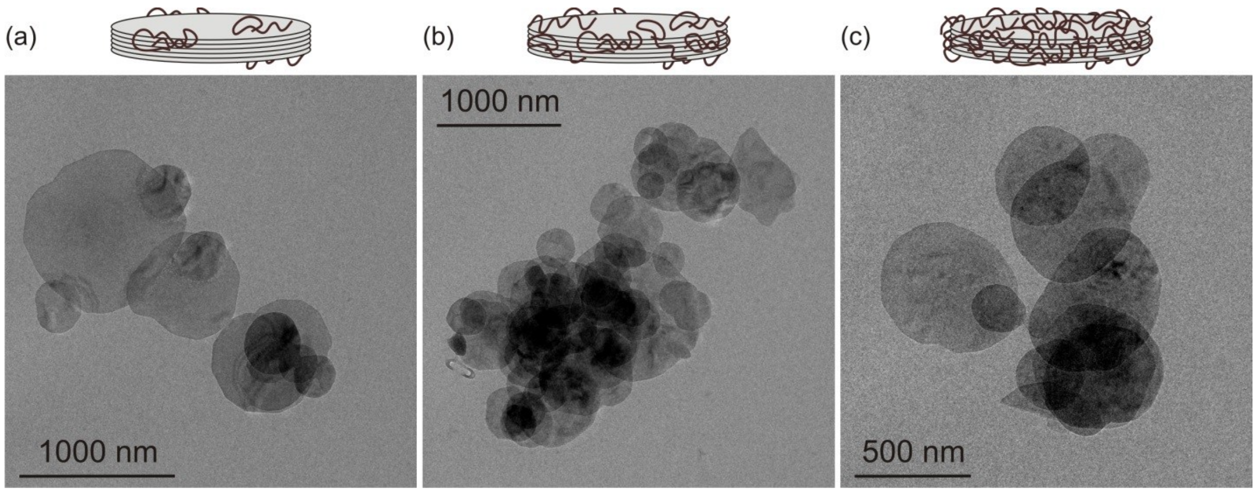

Fig. S1 TEM images of LDH2 particles at different heparin doses: 1 mg/g which refers to low dose and stable samples (a), 5 mg/g near the IEP with aggregated samples (b) and 30 mg/g where the particles reversed their charge and form stable dispersion (c).