Zeta-potential measurement of MXene suspensions

Date: 2021-04-14
Tags: *Synthesis Optimisation Zeta*
Created by: James Bird

Goal : Use Zetasizer to measure zeta potential of Ti_3C_2 **MXene nanoparticles in aqueous suspension**

Procedure :

Sample preparation

- MXene product suspensions, diluted to concentrations on the order of 1 x 10^{-2} and 1 x 10^{-3} wt% from select syntheses in [Experiment] Optimisation of MXene Synthesis - Execution of Plackett-Burman Screening Design
- Target concentration suspensions transferred to DTS1070 folded capillary cell with 1mL Luer syringe - cuvette exterior gently dried if necessary

Zetasizer instrument operation

Standard Operating Procedure (SOP) settings (zeta measurement type):

- Narrow band filter fitted
- Water dispersant (= 0.8872 cP, RI = 1.330, dielectric constant = 78.5)
- Smoluchowski Model for F(a) calculation
- Use dispersant viscosity as sample viscosity
- Temperature = 25 °C with 120 s equilibration time
- DTS1070 folded capillary cell
- Automatic measurement duration
- Three measurements per sample
- Automatic attenuation and voltage selection
- Auto mode analysis model

Results :

All sample details and measurement parameters are described in the table below. All individual measurements met the data quality criteria, and quality factors >> 1 indicate very good signal. All zeta potentials are highlighted in green to indicate that the mean value suggests a stable suspension as -30 mV. Red highlighted

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cells indicate that the deviation of the potential could indicate the suspension is not always stable.

Run / #	Concentration / wt%	Record N° / #	□ potential / mV	□ deviation / mV	Electrophoretic mobility (U_E) / □mcm/Vs	U_E deviation / □mcm/Vs	Quality factor	QF StdDev
13	1 x 10^{-2}	25-27	-45	7.41	-3.529	0.5810	6.95	2.29
13	1 x 10^{-3}	28-30	-34.3	7.92	-2.687	0.6208	5.35	1.52
1	1 x 10^{-2}	31-33	-41.9	7.1	-3.287	0.5566	8.54	1.15
16	1 x 10^{-2}	37-39	-44.6	22.8	-3.498	1.793	7.70	1.51
12	1 x 10^{-2}	40-42	-43.1	5.71	-3.375	0.4472	5.25	0.921

Raw datafile is found in simultaneous experiment (see [Experiment] Dynamic Light Scattering (DLS) for nanoparticle size-distribution acquisiton I) which can be read into the Zetasizer software program, .csv is an exported, comma-separated summary of the .dts datafile and .png is the plotted data; apparent zeta-potential is plotted against the total counts for that zeta-potential interval. Vertical lines spanning the whole plot height are mean zeta-potential values (quoted above), where the regions of matching colour spanning left and right of this value correspond to its standard deviation.

Conclusions:

Measurements taken of a product Ti_3C_2 suspension from the same run number should give reproducible zeta-potentials and distributions, which was not the case here for the synthesis product from Run #13, although the □-potential average and associated errors do overlap. When comparing □-potential against DLS measurement conditions, it's apparent that this concentration range and sample type is better suited to □-potential measurements. The fact that the □-potential measurements indicate suspension stability across all synthesis outputs, indicates that sample polydispersity, and not sedimenting particles are responsible for data quality criteria in DLS measurements not being met (see [Experiment] Dynamic

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Light Scattering (DLS) for nanoparticle size-distribution acquisiton I).

Attached files

Zeta_2021-04-14_Run13.png
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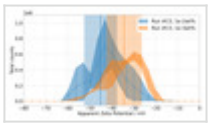

Zeta_2021-04-14.png
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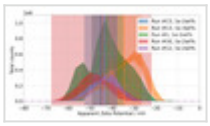

2021-04-14_Zeta.csv
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Unique eLabID: 20221108-a6ca66a0e763d4f52b745bff56672c91427f6ffe
Link: https://frankel-elab.manchester.ac.uk/experiments.php?mode=view&id=68