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Supplemental Information

**Effect of Polymer Composition and pH on Membrane Solubilization by
Styrene-Maleic Acid Copolymers**

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Supporting Material

Effect of polymer composition and pH on the solubilization of lipid membranes by styrene-maleic acid copolymers

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Supporting Materials & Methods

Acid–base titrations on SMA copolymers

The measured pH values were corrected for possible errors caused by non-linear electrode responses in the extreme pH regions using the Avdeef-Bucher four-parameter equation (**Eq. S1**) (1). In here, pH is the measured pH, α and k are constants, p_cH is the corrected pH, j_H and j_{OH} the parameters that account for the non-linear electrode responses in the extreme pH regions, K_w the water dissociation constant, and $[H^+]$ the corrected proton concentration. The parameters α , k , j_H , and j_{OH} were determined from weighted least squares fitting of alkalimetric titrations of known concentrations of HCl (blank titration) (1). Once the values of these parameters are known, Eq. S1 can be solved for every data point in the titration curve.

$$\text{(Eq. S1)} \quad pH = \alpha + k p_cH + j_H [H^+] + j_{OH} \frac{K_w}{[H^+]}$$

Curves of the corrected pH versus the volume of added base were converted into curves of protonation state/ionization state versus pH according to **Eq. S2** in which n_H is the protonation state, $[OH^-] = 10^{(p_cH - pK_w)}$ the hydroxide concentration, $[K^+] = \frac{[KOH]}{V_{initial} + V_{added}}$ the potassium concentration, $[H^+] = 10^{-p_cH}$ the proton concentration and $[SMA]$ the monomol concentration of the SMA variant used in the titration.

$$\text{(Eq. S2)} \quad n_H = 2 + \frac{[OH^-] - [K^+] - [H^+]}{[SMA]}$$

Figure S1

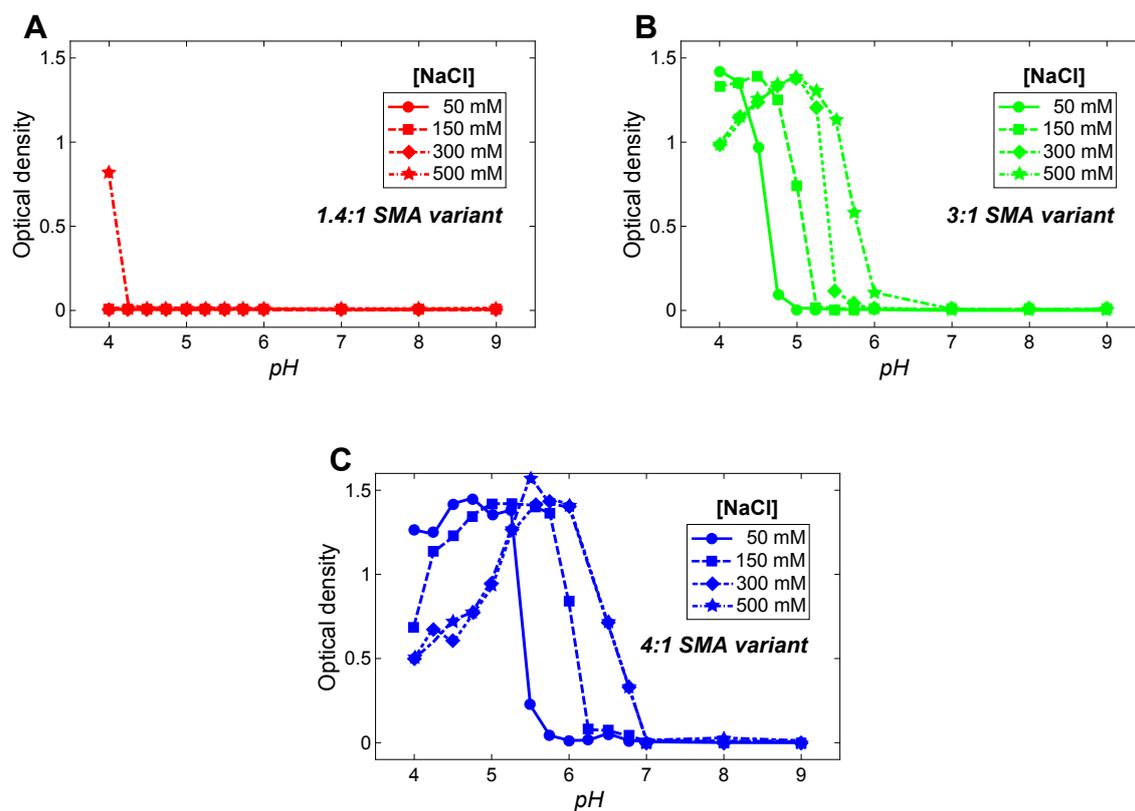


Figure 1: pH dependent solubility of different SMA variants in a 40 mM Britton-Robinson buffer at varying ionic strengths. All measurements have been performed at a polymer concentration of 0.1% (w/v). The optical density was measured at $\lambda=350$ nm. Lines have been added to guide the eye.

Figure S2

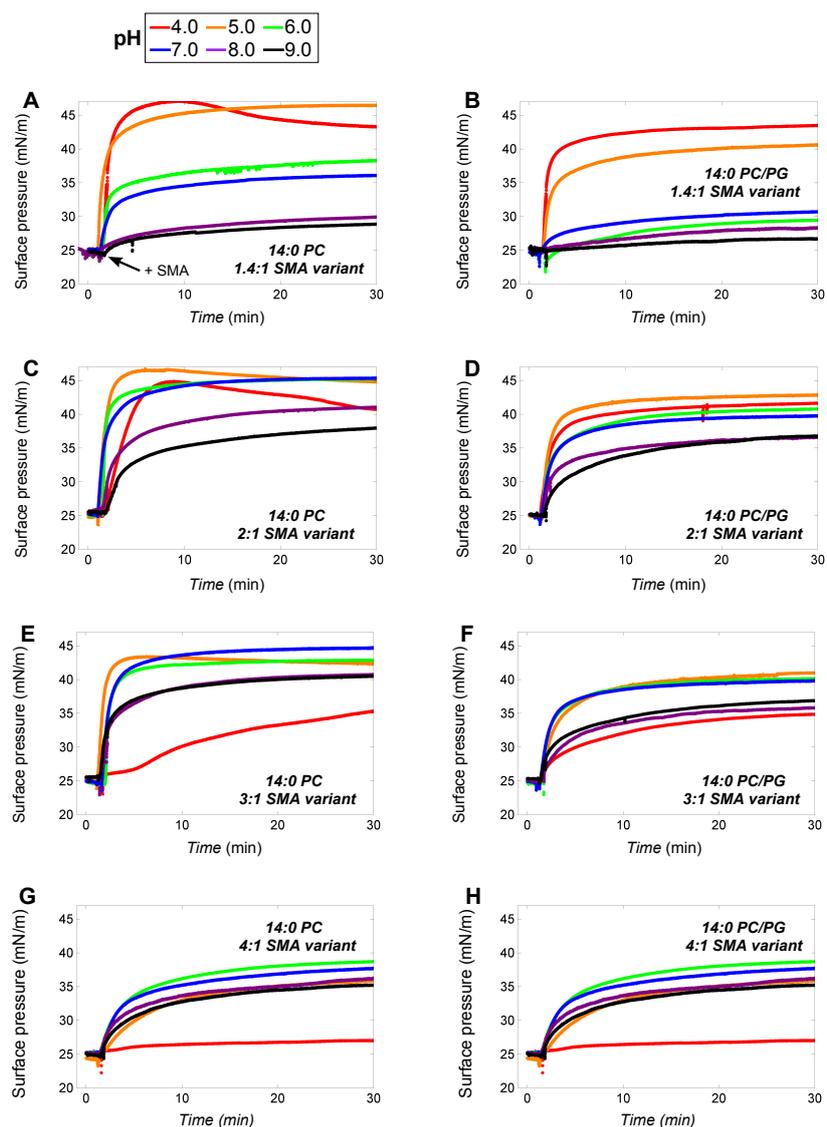


Figure 2: Insertion of the SMA variants in a di-14:0 PC and di-14:0 PC/PG (1:1 mol) lipid monolayer at different pH values. In all experiments the initial surface pressure was 25 mN/m, NaCl concentration is 150 mM and SMA concentration is 0.005% (w/v). Subsequent addition of more SMA did not increase the observed surface pressure any further, demonstrating that the experiments were performed under conditions of excess SMA.

Figure S3

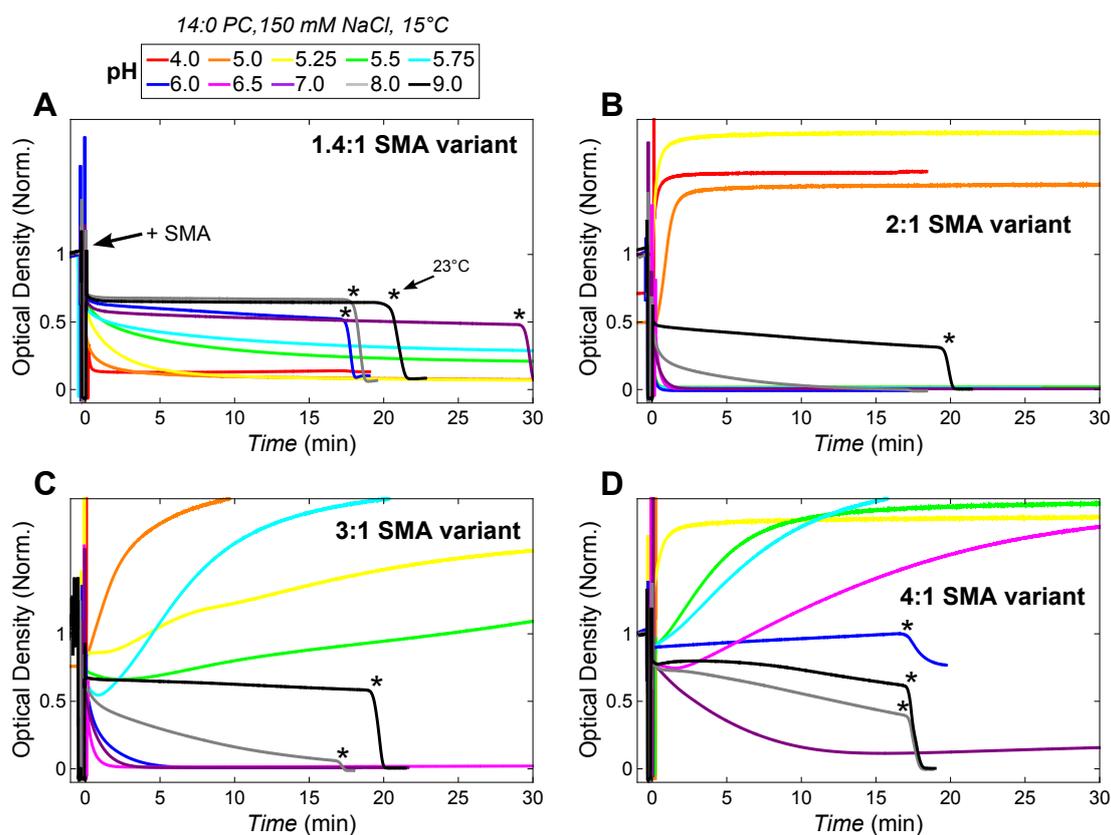


Figure 3: Time course solubilization of di-14:0 PC vesicles at 15 °C (gel phase) by each SMA variant at different pH values. The asterisks denote the time where the temperature was set to 23 °C, which is the T_m of 14:0 PC (2). For the 2:1, 3:1, and SMA 4:1 variants at lower pH, the relative optical density rises above 1. This means that the optical density increases after SMA addition, which is likely to be caused by polymer aggregation or clustering of vesicles due to the polymer. All measurements have been performed at a polymer concentration of 0.1% (w/v).

Supporting References

- [1] Avdeef, A., 1983. Weighting scheme for regression analysis using pH data from acid-base titrations. *Analytica Chimica Acta* 148:237 – 244. <http://www.sciencedirect.com/science/article/pii/S0003267000851685>.
- [2] Silvius, D. J. R., 1982. Thermotropic phase transitions of pure lipids in model membranes and their modifications by membrane proteins, volume Lipid-Protein Interactions. John Wiley & Sons, Inc. New York.