Synthesis of anionic and cationic corroles and study of their complexing ability and photodynamic activity towards DNA and albumin

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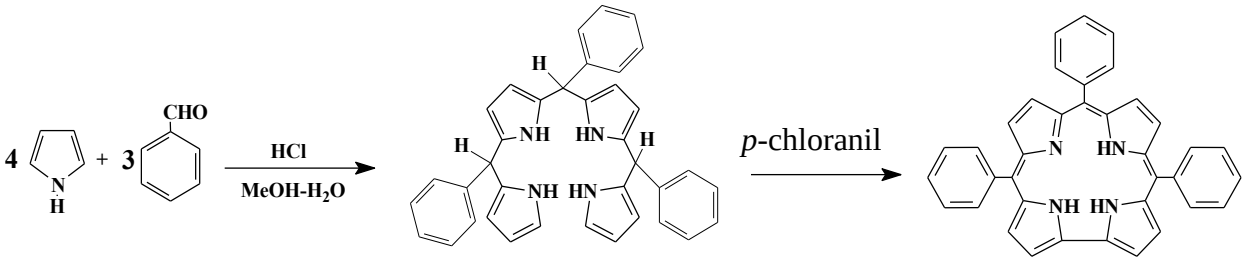
Synthesis procedure

Triphenylcorrol

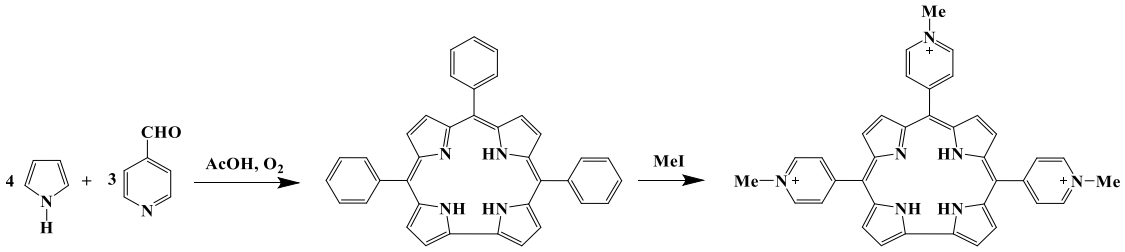


0.7 ml (10 mmol) of pyrrole and 0.5 ml (5 mmol) of benzaldehyde were dissolved with stirring in a mixture of 200 ml of methanol and 200 ml of water in the 1000 ml flask equipped with a magnetic stirrer. 4.3 ml of concentrated hydrochloric acid was added to the reaction mixture, and the mixture was stirred at room temperature for 3 hours. The precipitate formed was filtered off and dissolved in 300 ml of chloroform. The chloroform solution was shaken with water in a separating funnel, the organic fraction was separated and dried over anhydrous Na_2SO_4. 1.23 g (5 mmol) of p-chloranil was added to the chloroform solution and it was boiled in a flask equipped with a reflux condenser for 1 hour. Then the solvent was distilled off, the residue in the flask was washed with a 5% aqueous solution of KOH, the precipitate was filtered off, washed with water, and dried in air to constant weight. The dried residue was dissolved in 150 ml of methylene chloride and chromatographed on a column of silica gel (L60), eluting with methylene chloride. The solvent was evaporated to 5 ml and triphenylcorrole was precipitated with 50

ml of methanol. The precipitate was filtered off, washed with methanol, and dried in air to constant weight. Yield 0.27 g (30%). R_f = 0.35 (benzene). UV-Vis ($CHCl_3$): λ, nm (logε): 647 (4.06); 615(4.16); 576 (4.25); 415 (5.12). ^{1}H NMR δ, ppm: 8.94s; 8.90s; 8.60s; 8.59s (4x2H, β-H); 8.38d (4H, 2.6-H5.15-Ph); 8.19d (2H, 2.6-H-10-Ph); 7.70-7.80 m (9H, 3,4,5-H-Ph); -1.98bs (3H, NH) ($CDCl_3$, 500 MHz). MS MALDI $[M+H]^+$: found 526.43; calculated for $C_{37}H_{26}N_4$ 526.64.

Polysulfophenylcorrole (mixture of tri(4-sulfophenyl)corrole and tetrasulfotriphenylcorrole)

The mixture of 0.2 mg (0.38 mmol) of 5,10,15-triphenylcorrol and 7 ml (0.13 mol) of concentrated H_2SO_4 was heated with magnetic stirring to 100 °C for 4 hours in the 50 ml flask. Then the mixture was cooled, diluted by half with water, centrifuged for 30 min. The solution was decanted from the precipitate, the precipitate was washed several times with acetone (until the acetone solution drained from the precipitate became transparent and slightly coloured). After centrifugation, the remaining precipitate was dried in air at room temperature. The dried precipitate was dissolved in 20 ml of 5% ammonia solution, poured onto a Petri dish and dried in air at room temperature. The resulting precipitate was dissolved in methanol, filtered off from inorganic impurities, the methanol solution was poured onto a Petri dish and dried in air at room temperature. Yield 0.150 g (43%) of polysulfotriphenylcorrool (mixtures of compounds of tetra- and tri-sulfo derivatives, with predominance of tri-sulfocorrole). Purity >99%. UV-Vis (H_2O): λ, nm (logε): 415(5.01); shoulder 460(4.28); 511(4.16); 547(4.04); 586(3.99). MS MALDI $[M+H]^+$: found 816.471; 913.8898 calculated for $C_{37}H_{35}N_7O_9S_3$ 817.90; for $C_{37}H_{38}N_8O_{12}S_4$ 914.99.



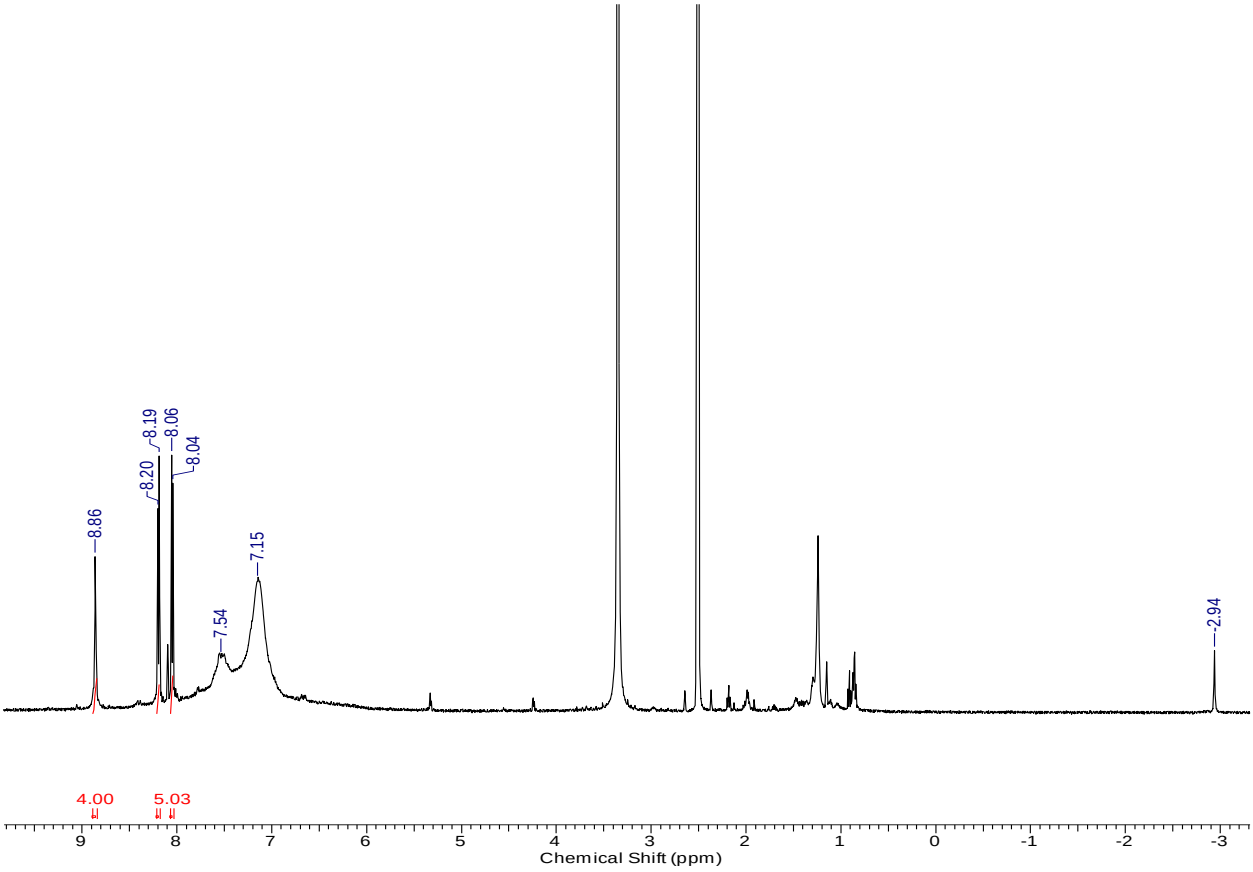
Tri(4-pyridyl)corrole

250 ml of acetic acid was heated to boiling in the 500 ml flask equipped with a reflux condenser, an air supply, and a dropping funnel, and a mixture of 4.2 ml (60.5 mmol) of pyrrole and 2 ml (20 mmol) of 4-pyridylcarbaldehyde was added dropwise to it. The mixture was boiled while passing a current of air for 3 hours. The mixture was then cooled to room temperature, 150 ml of water was added and then neutralized with 5% ammonia (tri(4-pyridyl)corrole precipitated as a dark precipitate). The precipitate formed was filtered off, washed with water, and dried

in air at room temperature. The dried precipitate was dissolved in 150 ml of chloroform and chromatographed twice on a column of silica gel (L60), eluting successively with a mixture of chloroform-methanol (1:2), then (1:1). The solvent was evaporated. Yield 0.35 g (10%). Purity >99%. UV-Vis ($CHCl_3$): λ, nm (log ε): 651 shoulder, (3.31) 619 shoulder (3.50), 576 (3.72), 417 (4.37). ^{1}H NMR (C_6D_6): 7.87 (d, J=5.1 Hz, 2H), 7.99 (d, J=5.1 Hz, 4H), 8.35 (d, J=4.8 Hz, 2H), 8.43 (d , J=4.2 Hz, 2H), 8.66 (d, J=4.8 Hz, 2H), 8.78 (d, J=4.2 Hz, 2H), 9.02 (brs, 6H).

Tri(N-methylpyridin-4-yl)corrole triiodide

0.342 g (0.645 mmol) of 5,10,15-tris(4-pyridyl)corrole was dissolved with stirring in 4 ml of a mixture of chloroform and methanol (10:1) in the 1000 ml flask equipped with a magnetic stirrer. Then 0.5 ml (8.03 mmol) of methyl iodide was added to the reaction mixture and heated to 60°C with stirring on a magnetic stirrer for 1 h. The reaction mixture was cooled to room temperature, the solution was decanted from the precipitate of the reaction product. The precipitate was washed with 5 ml of chloroform, dissolved in methanol, the methanol solution was poured onto a Petri dish and dried in air at room temperature. Yield 0.127 g (21%). UV-Vis (H_2O): λ, nm (log ε): 422 (4.37) 492 (3.81) 661 (1.99). ^{1}H NMR: 7.81 (d, 2H), 7.90 (d, 4H), 8.27 (d, 2H), 8.48 (d, 2H), 8.60 (d, 2H), 8.71 (d, 2H), 9.02(brs, 6H). 4.72 s (9H, CH_3N) (DMSO-d^6) MS MALDI $[M+H]^+$: found 531.78; calculated for $C_{37}H_{34}I_3N_7$ 531.61.



^{1}H NMR spectrum of a mixture of tri- and tetrasulfophenylcorroles

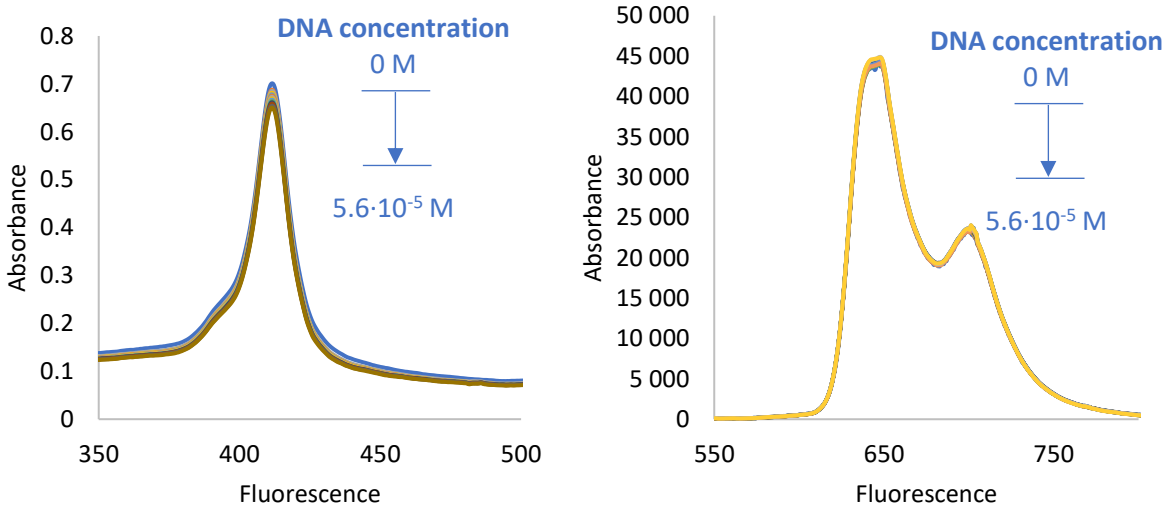


Figure S1. UV-Vis and fluorescence (λ_{ex}=425 nm) spectra of **pSCor** during titration with DNA. Titration was performed by adding DNA (1.6 mM) 10 µl (7 steps) to 2 ml of corrole solution in Tris-HCl buffer in a cuvette with stirring at a temperature of 25 °C.

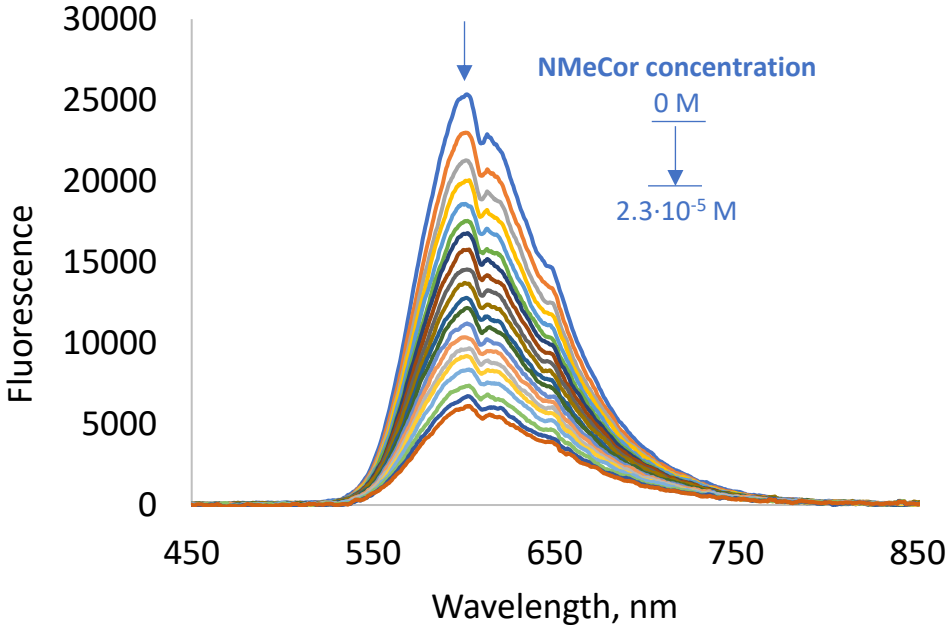


Figure S2. Fluorescence spectra (λ_{ex}=295 nm) of titration of DNA ($1.1 \cdot 10^{-4}$ M)-EtBr ($1.3 \cdot 10^{-5}$ M) complex with **NMeCor**. Titration was performed by adding of **NMeCor** (0.45 mM) 5 µl (19 steps) to 2 ml of DNA-EtBr complex in Tris-HCl buffer in a cuvette with stirring at a temperature of 25 ℃.

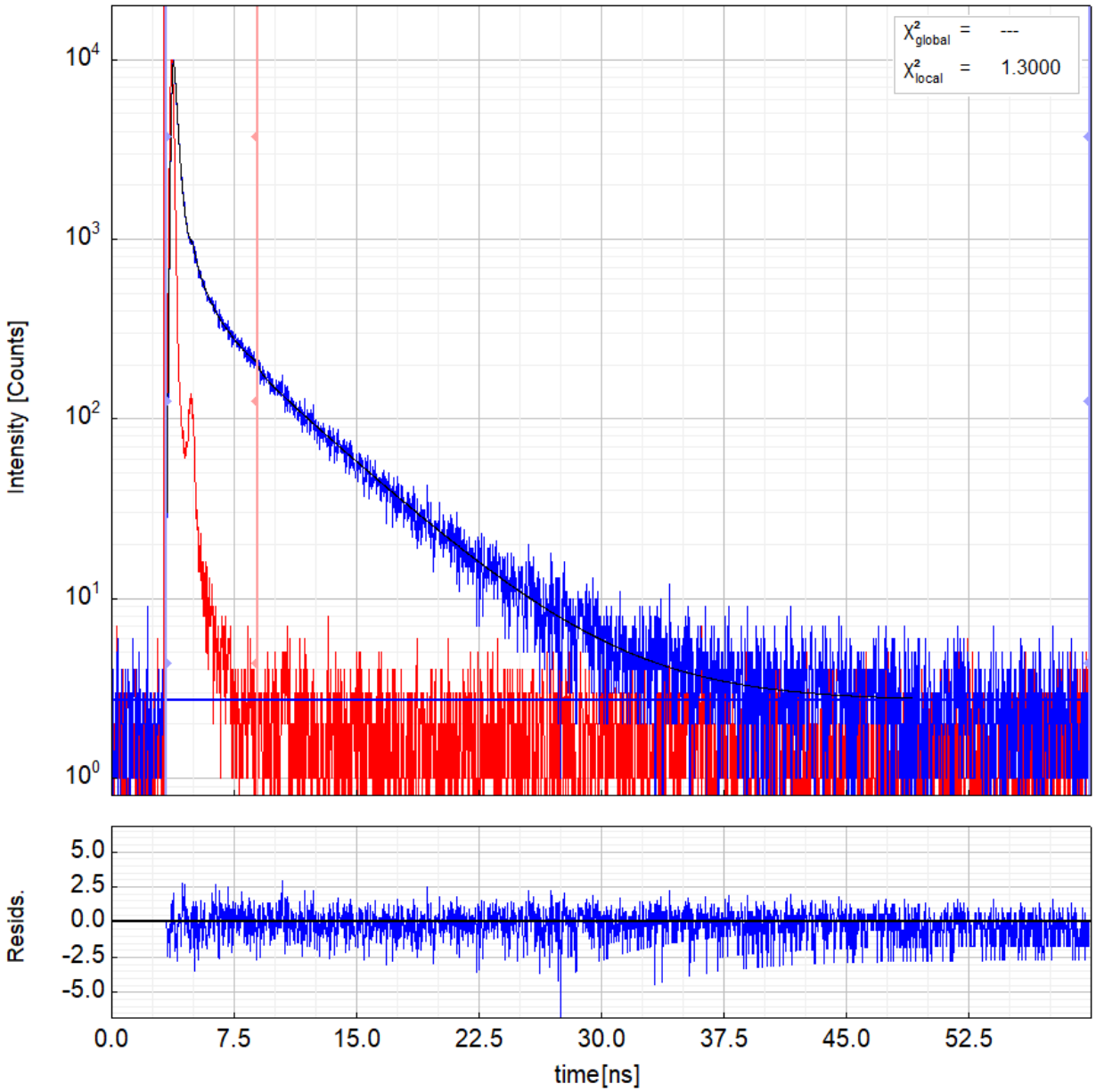


Figure S3. Fluorescence decay rate of NMeCor in Tris-HCl buffer.

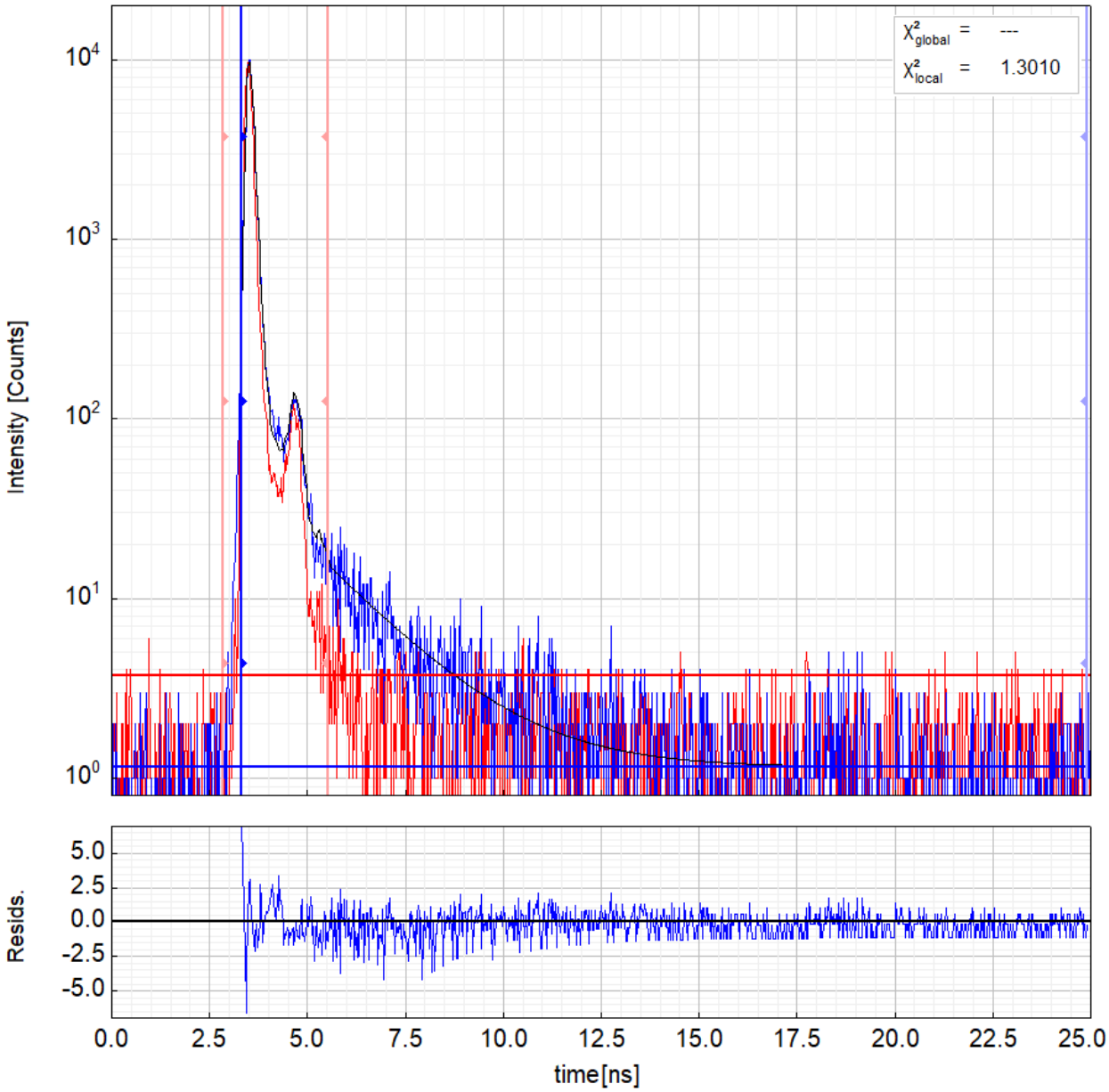


Figure S4. Fluorescence decay rate of complex NMeCor with DNA in Tris-HCl buffer.

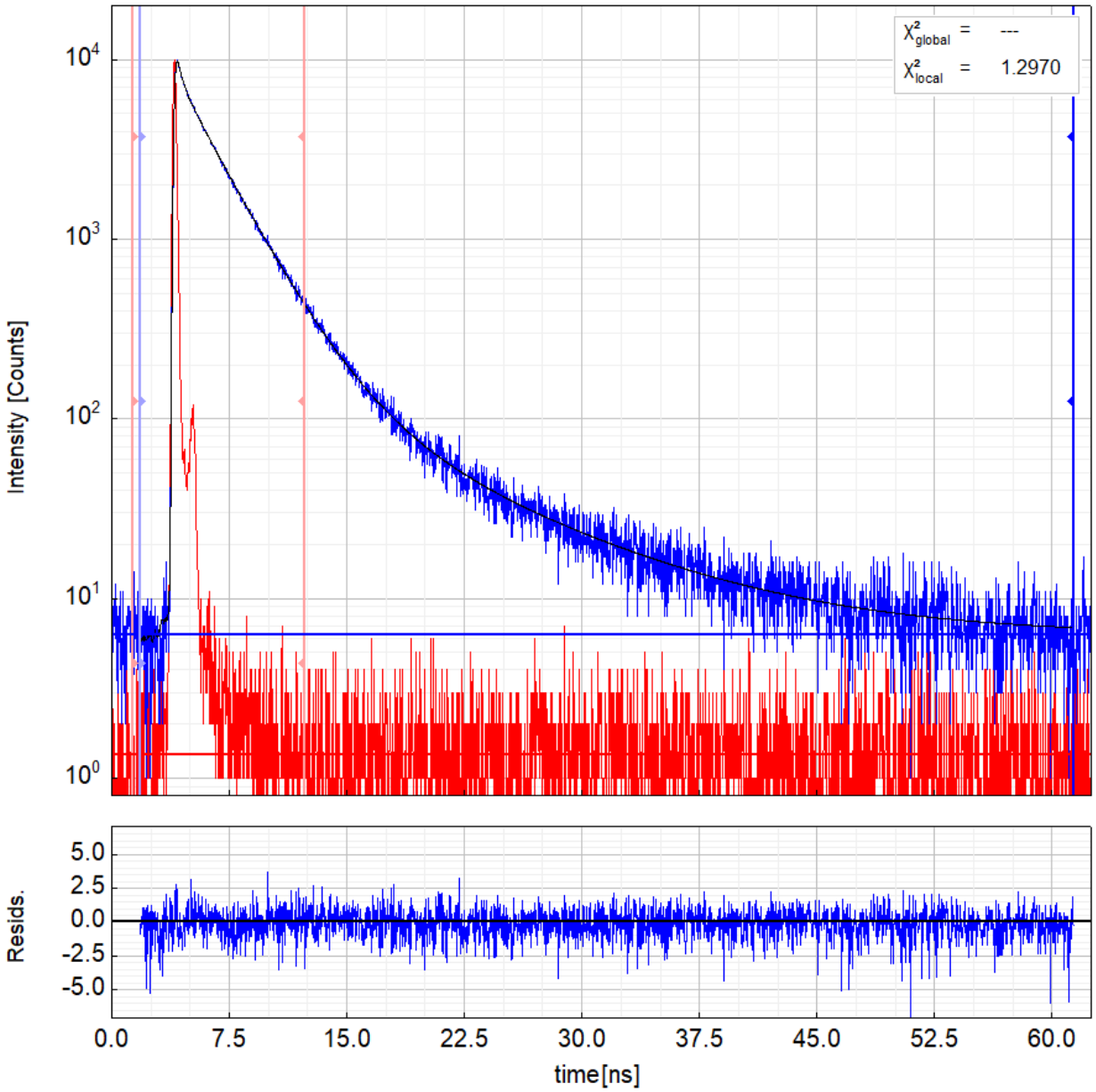


Figure S5. Fluorescence decay rate of pSCor in Tris-HCl buffer.

Probable pathways of radical reactions

$$PS + h\nu \rightarrow {}^{3}PS^{*} \quad \text{(E1)}$$

$${}^{3}PS^{*} + O_2 \rightarrow PS + {}^{1}O_2 \quad \text{(E2)}$$

$${}^{1}O_2 + NaN_3 \rightarrow NaN_3{}^{*} + O_2 \text{ (Physical quenching)} \quad \text{(E3)}$$

$${}^{1}O_2 + N_3^- \rightarrow N_3^{\cdot} + O_2^{\cdot -} \quad \text{(E4)}$$

$${}^{1}O_2 + 3I^- + 2H_2O \rightarrow I_3{}^- + 2H_2O_2 \quad \text{(E5)}$$

$$H_2O_2 + 3I^- + 2H^+ \rightarrow I_3^- + 2H_2O \quad \text{(E6)}$$

$$H_2O_2 + e \rightarrow OH^{\cdot} + OH^- \quad \text{(E7)}$$

$$OH^{\cdot} + I^- \rightarrow I^{\cdot} + OH^- \quad \text{(E8)}$$

$$OH^{\cdot} + 2I^- \rightarrow I_2^{\cdot -} + OH^- \quad \text{(E9)}$$

$$I^{\cdot} + I^- \rightarrow I_2^{\cdot -} \quad \text{(E10)}$$

$$I_2^{\cdot -} + I_2^{\cdot -} \rightarrow I_3^- + I^- \quad \text{(E11)}$$

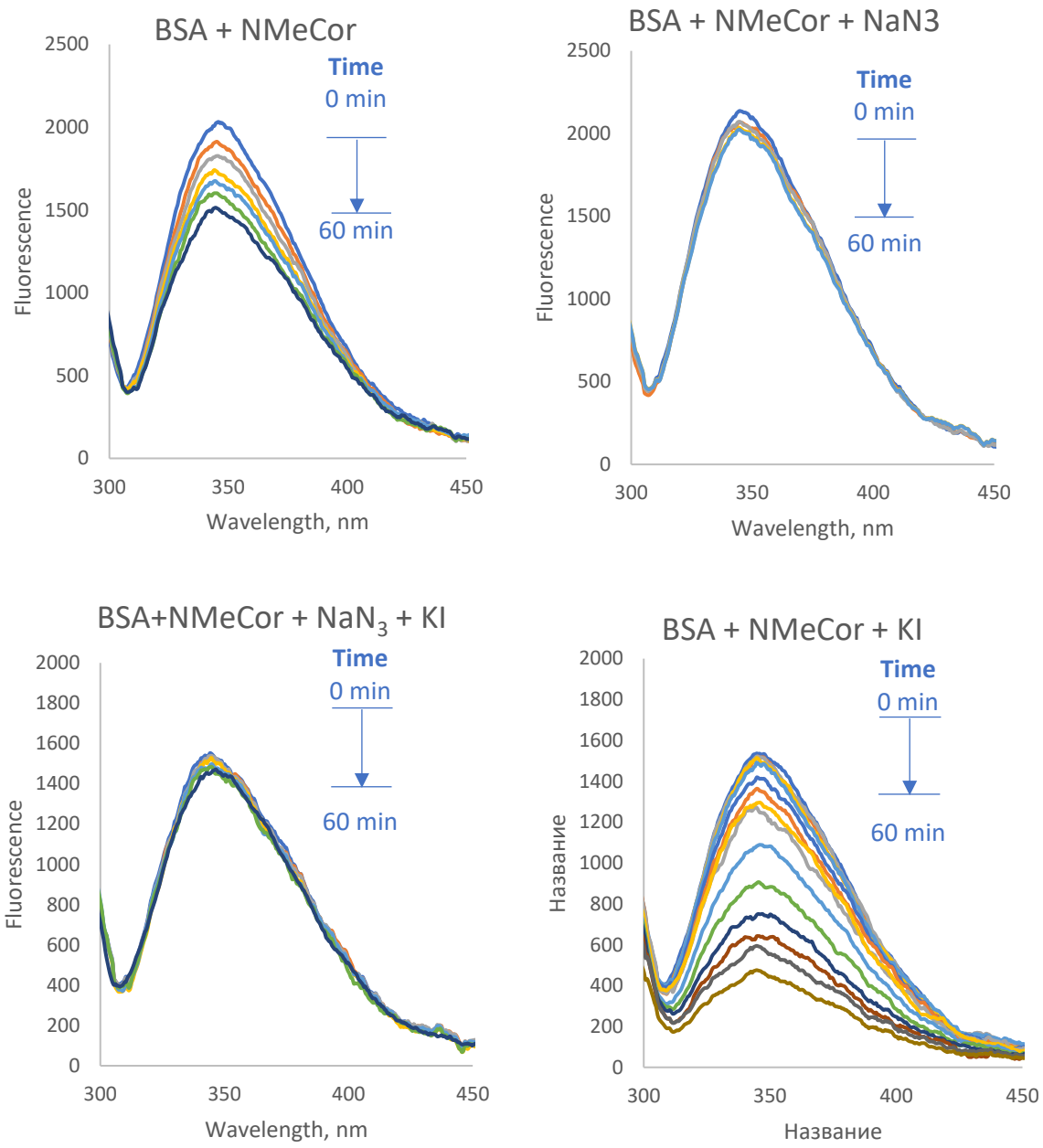


Figure S6. Corrected fluorescence spectra upon irradiation of a complex of BSA (0.08 wt %) with NMeCor ($1.7 \cdot 10^{-5}$ M) depending on the presence of KI (50 mM) and NaN_3 (15 mM).

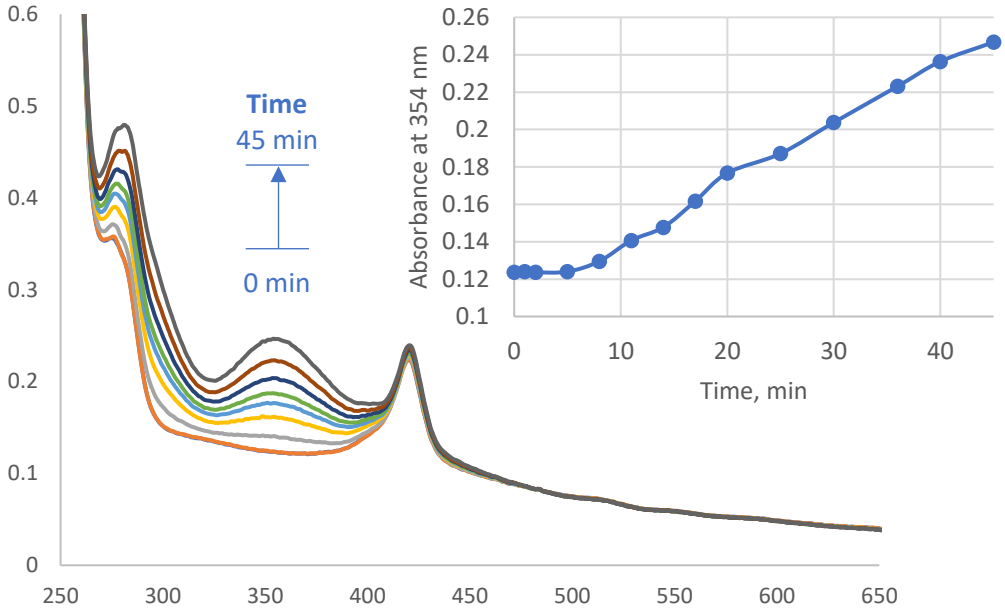


Figure S7. UV-Vis spectra of solution of BSA (0.08 wt %) with pSCor ($1.7 \cdot 10^{-5}$ M) and KI (50 mM) in PBS irradiated with light 425 nm. Absorbance at 454 nm on inset.

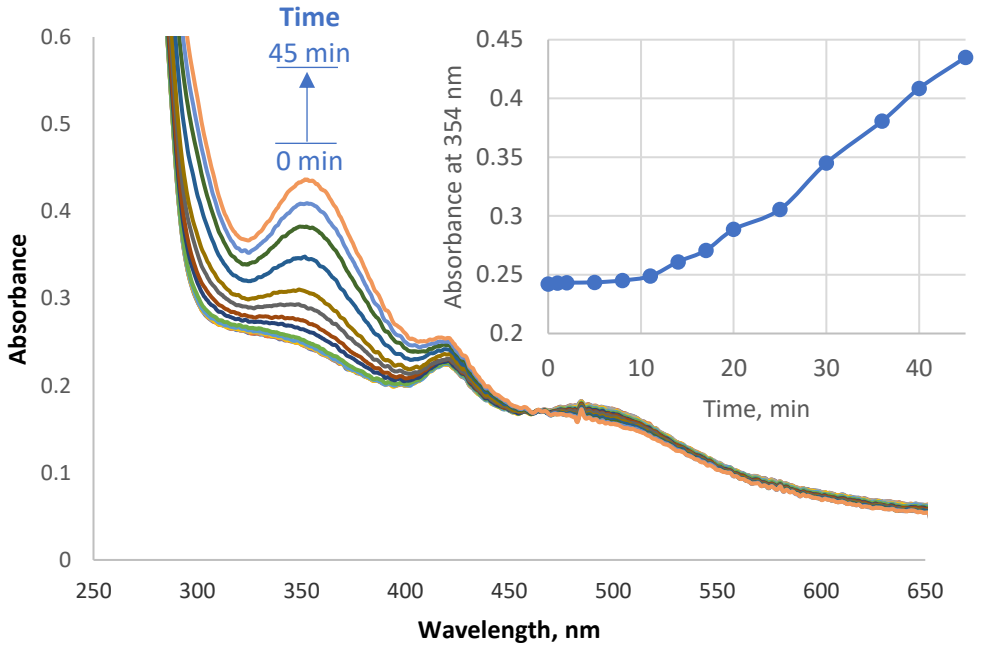


Figure S8. UV-Vis spectra of solution of BSA (0.08 wt %) with NMeCor ($1.7 \cdot 10^{-5}$ M) and KI (50 mM) in PBS irradiated with light 425 nm. Absorbance at 354 nm on inset.