

Electronic supplementary information (ESI)

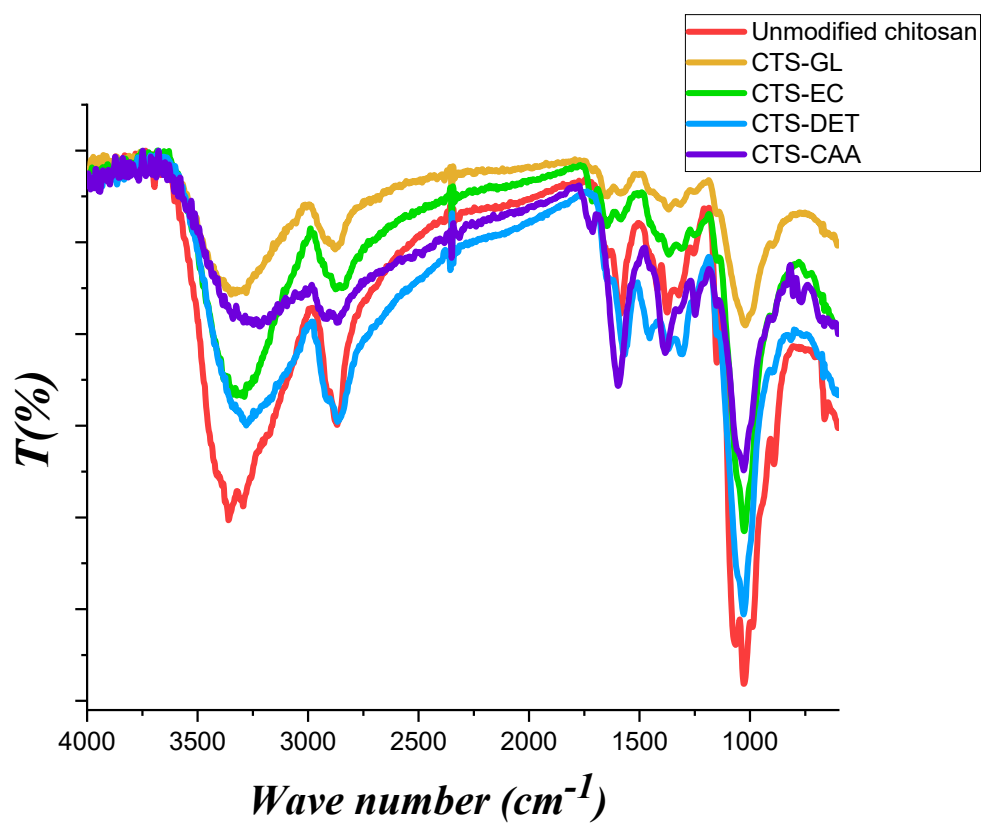
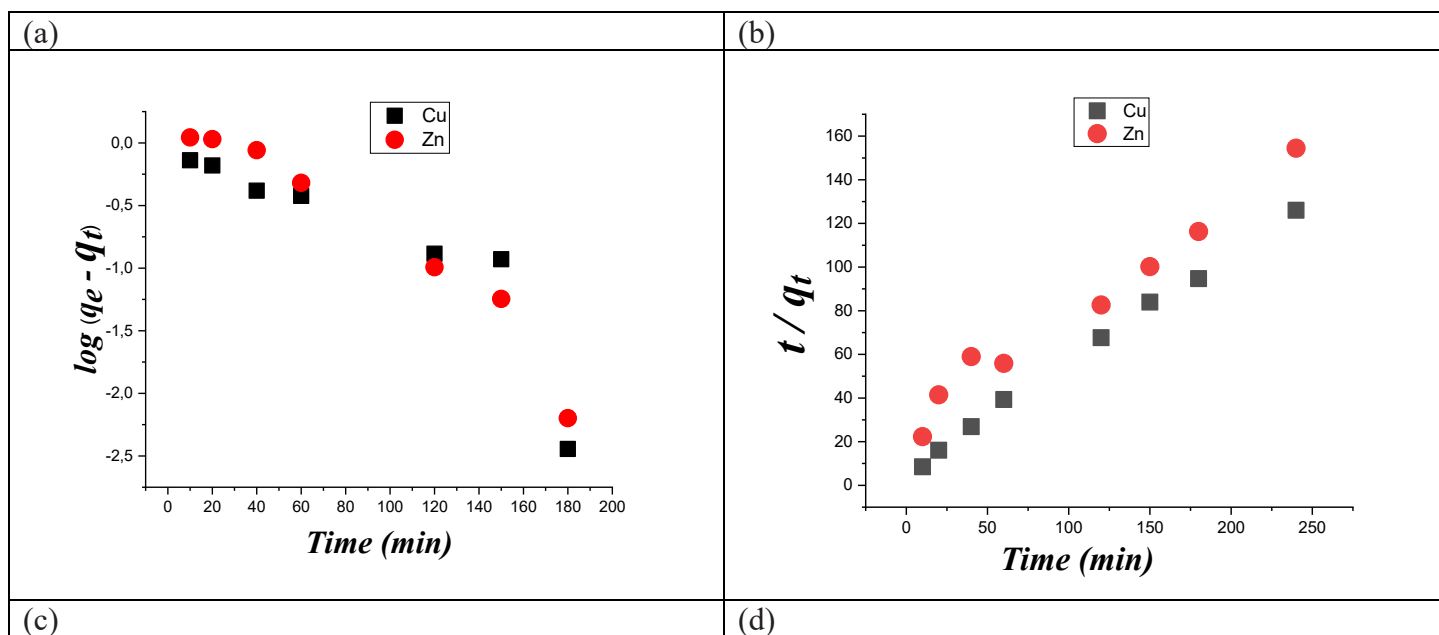


Figure S1. FT-IR spectra of (Unmodified chitosan), (CTS-GL), (CTS-EC), (CTS-DET) and (CTS-CAA) [full wavenumber range].



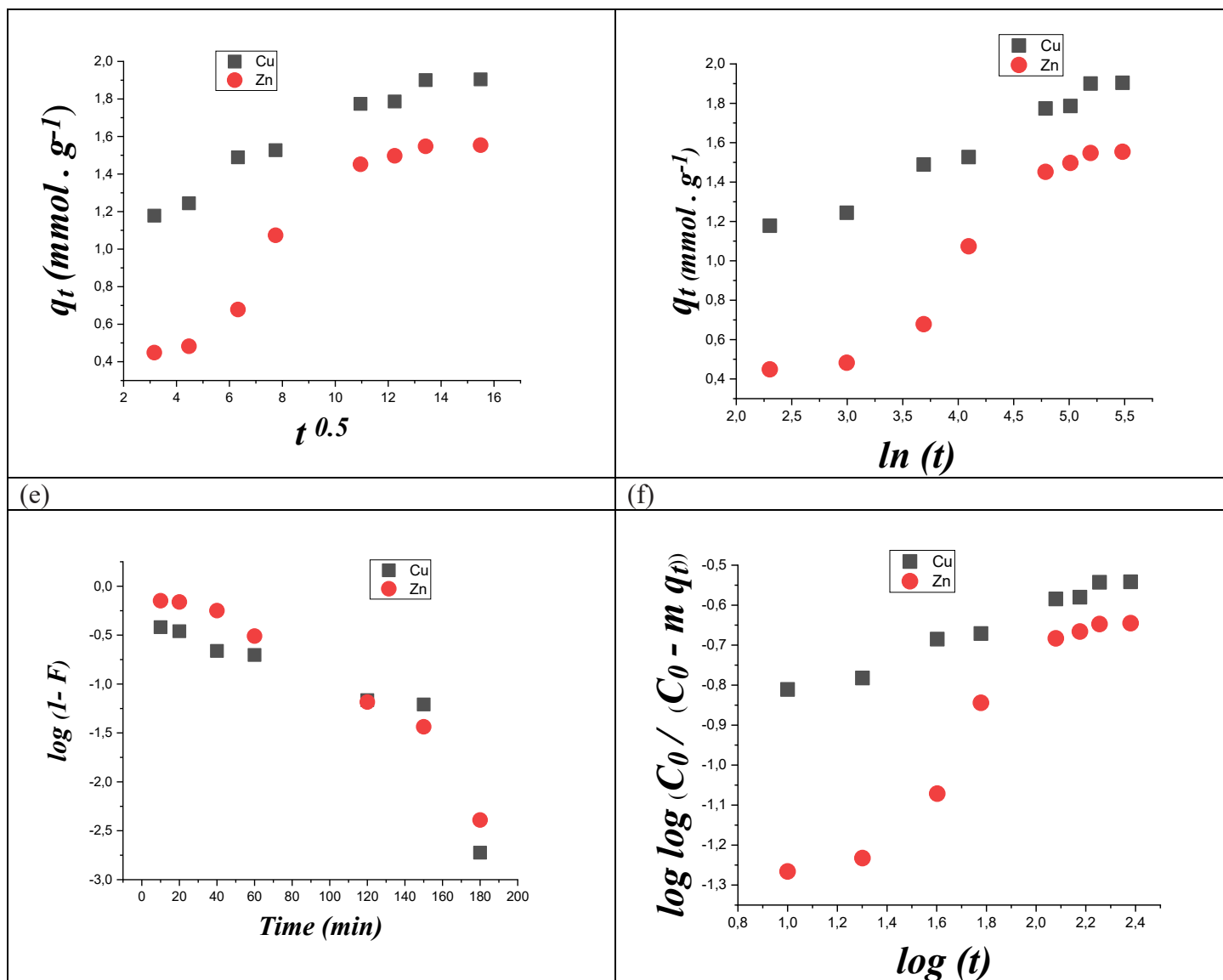


Figure S2. Pseudo-first-order plot with slope equal $(-K_1/2.303)$ and the intercept equal $\log q_1$ (a), Pseudo-second-order plot with slope equal $(1/q_2)$ and the intercept equal $(1/K_2 q_2^2)$ (b), Intraparticle diffusion plot with slope equal (K_i) and the intercept equal (Z) (c), Elovich's equation plot with slope equal $(1/B)$ and the intercept equal $[(1/B) \ln(aB)]$ (d), Dumwald-Wagner plot with slope equal $(-K_{fd}/2.303)$ (e), Bangham plot with slope equal (γ) and intercept equal $\log(m K_\gamma / 2.303 V)$ (f).

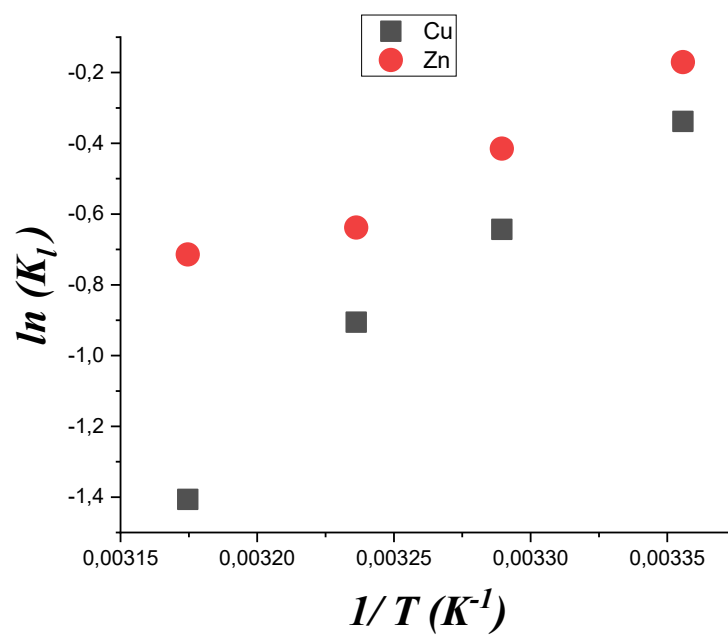
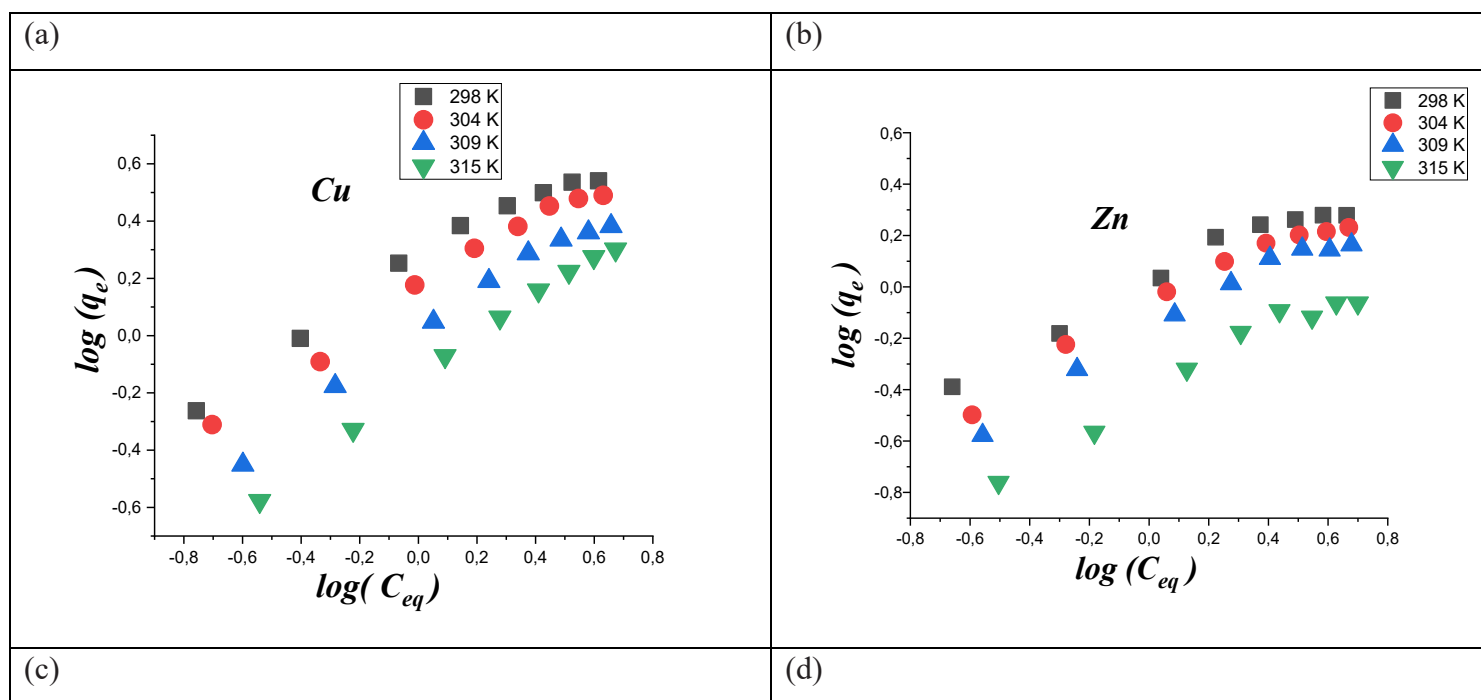


Figure S3. Representation of Van't Hoff equation for the adsorption of the metal ions on (CTS-CAA).



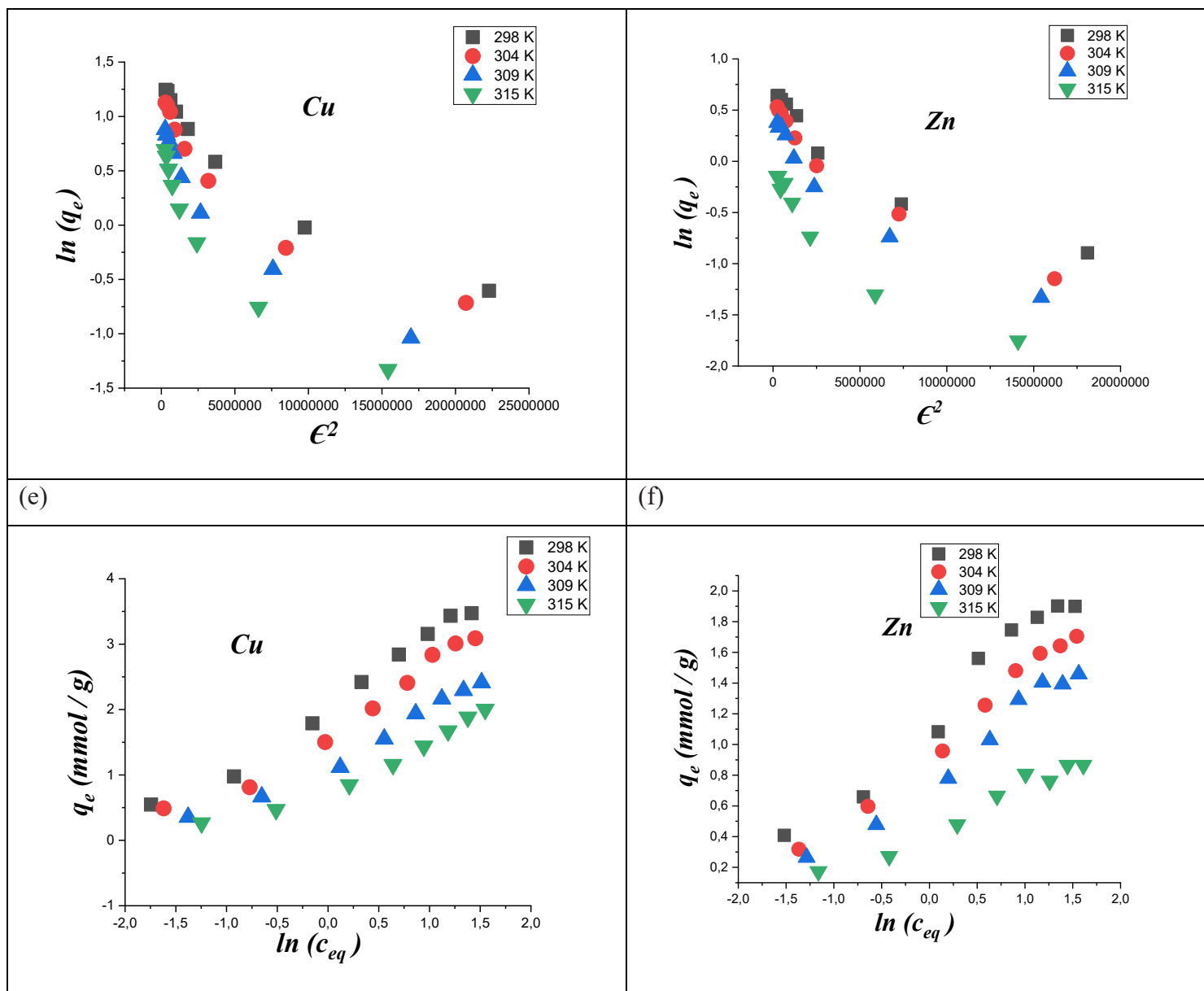


Figure S4. Freundlich plots for copper (a) and zinc (b). Dubinin-Radushkevich plots for copper (c) and zinc (d). Temkin plots for copper (e) and zinc (f).

Table S1. Kinetic parameters have been estimated by fitting the kinetic models with the experimental results.

| Kinetic model | Model parameters | Copper | Zinc |
|-------------------------------|------------------|--------|--------|
| Equilibrium sorption capacity | q_e | 1.904 | 1.553 |
| Pseudo -first- order | q_1 | 1.282 | 2.166 |
| | K_1 | 0.024 | 0.028 |
| | R^2 | 0.7825 | 0.9433 |
| Pseudo-second-order | q_2 | 1.991 | 1.948 |
| | K_2 | 0.0393 | 0.0099 |

| | | | |
|------------------------------|-----------------|--------|--------|
| Weber Morris diffusion model | R ² | 0.9977 | 0.9753 |
| | K _i | 0.0627 | 0.1056 |
| | Z | 1.022 | 0.1169 |
| | R ² | 0.9578 | 0.9275 |
| Elovich's equation | B | 4.0064 | 2.385 |
| | a | 2.291 | 0.0854 |
| | R ² | 0.9786 | 0.9409 |
| Dumwald-Wagner | K _{fd} | 0.024 | 0.028 |
| | R ² | 0.7825 | 0.9433 |
| Bangham kinetic model | K _γ | 26.479 | 4.038 |
| | γ | 0.212 | 0.533 |
| | R ² | 0.9818 | 0.9496 |

Table S2. Freundlich, Dubinin-Radushkevich and Temkin parameters for copper

| <i>T</i> (K) | <i>Freundlich parameters</i> | | | <i>Dubinin-Radushkevich parameters</i> | | | | <i>Temkin parameters</i> | | | |
|-----------------|------------------------------|----------------------|-----------------------|--|-----------------------|-------------------|-----------------------|--------------------------|----------------------------|--------------------------|-----------------------|
| | <i>n</i> | <i>K_f</i> | <i>R</i> ² | <i>Q_S</i> | <i>K_{DR}</i> | <i>E (kJ/mol)</i> | <i>R</i> ² | <i>B (kJ/mol)</i> | <i>A_T (L/g)</i> | <i>b*10⁻³</i> | <i>R</i> ² |
| 298 | 1.66 | 1.737 | 0.9758 | 3.555 | 2.00E-07 | 1.581 | 0.9812 | 2.318 | 2.476 | 1.068 | 0.9859 |
| 304 | 1.58 | 1.407 | 0.9871 | 3.166 | 2.00E-07 | 1.581 | 0.963 | 2.129 | 2.25 | 1.186 | 0.971 |
| 309 | 1.48 | 0.988 | 0.9854 | 2.511 | 3.00E-07 | 1.29 | 0.987 | 1.739 | 2.031 | 1.477 | 0.9768 |
| 315 | 1.35 | 0.6908 | 0.9961 | 1.983 | 4.00E-07 | 1.118 | 0.9571 | 1.487 | 1.809 | 1.76 | 0.9591 |

Table S3. Freundlich, Dubinin-Radushkevich and Temkin parameters for Zinc

| <i>T</i> (K) | <i>Freundlich parameters</i> | | | <i>Dubinin-Radushkevich parameters</i> | | | | <i>Temkin parameters</i> | | | |
|-----------------|------------------------------|----------------------|-----------------------|--|-----------------------|-------------------|-----------------------|--------------------------|----------------------------|--------------------------|-----------------------|
| | <i>n</i> | <i>K_f</i> | <i>R</i> ² | <i>Q_S</i> | <i>K_{DR}</i> | <i>E (kJ/mol)</i> | <i>R</i> ² | <i>B (kJ/mol)</i> | <i>A_T (L/g)</i> | <i>b*10⁻³</i> | <i>R</i> ² |
| 298 | 1.86 | 0.989 | 0.9642 | 2.094 | 2.00E-07 | 1.58 | 0.9874 | 1.267 | 2.502 | 1.955 | 0.9687 |
| 304 | 1.73 | 0.807 | 0.9686 | 1.775 | 3.00E-07 | 1.29 | 0.9935 | 1.161 | 2.287 | 2.175 | 0.9912 |
| 309 | 1.63 | 0.647 | 0.9745 | 1.566 | 3.00E-07 | 1.29 | 0.9773 | 1.046 | 2.11 | 2.455 | 0.9772 |
| 315 | 1.63 | 0.373 | 0.9675 | 0.935 | 3.00E-07 | 1.29 | 0.959 | 0.634 | 2.024 | 4.125 | 0.9661 |