Comments by Anonymous Referee:

General Comments:

This study proposes an in situ real-time measurement method based on dark-field microscopy to investigate the photochemical oxidation of SO_2 in nanoscale sea-salt aerosols. By combining the hygroscopic GF with the ZSR mixing rule, the authors retrieve single-particle reaction kinetics and reveal a non-monotonic dependence of the reaction rate on particle size. The method is innovative, and the research falls within the scope of ACP. However, the scientific significance and the completeness of the experimental design require further clarification and strengthening. Acceptance is recommended after addressing the following points.

Major comments:

1) While this study achieves in situ observation of reaction kinetics for individual nano-aerosol particles—a notable methodological advance—what specific atmospheric chemistry problem does it aim to solve? For instance, does it target the mechanism of rapid sulfate formation during haze episodes? How do the findings directly improve existing atmospheric chemistry models or pollution assessments?

2) In this study, the hygroscopic growth of particles is derived from grayscale intensity using dark-field microscopy, and reaction kinetics are inferred based on the ZSR rule. To verify the reliability of the optical method, please provide the measured hygroscopic GF results for pure NaCl particles under the same experimental conditions (e.g., RH range 25%–85%) and compare them with theoretical models (e.g., E-AIM) or classical HTDMA data. If direct measurements were not performed, please specify whether GF parameters for NaCl from validated literature were adopted and discuss their applicability within your optical measurement system.

3) In Section 2.2 and Figure 3b, the IC measurements provided independent validation of the GF-based kinetic analysis, showing a "consistent linear trend" when plotting $\ln(C_0/C)$ versus time. However, the manuscript does not provide a clear, step-by-step explanation of how the IC data (presumably aqueous concentrations of anions like sulfate or chloride from filter extracts) were converted into the dimensionless $\ln(C_0/C)$ values used in Figure 3b.

4) All experiments were conducted at 85% RH under UV illumination. How representative is this condition for marine or polluted boundary layer environments? Would the curvature effect be expected to persist at lower RH?