

Influence of catalyst zeta potential on the activation of persulfate

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Introduction

The effect of the zeta potential of nano zero-valent iron (nZVI) and carbocatalyst on the activation of persulfate was investigated. The oxidation experiments were performed on three different compounds, with variously modified nZVI and three distinct carbocatalysts. From the obtained results, an evident linear correlation between nanoparticles' zeta potential and reaction rate constants of these three compounds may be observed.

Methodology

As a nZVI source, a commercial nanoscale zero-valent iron (Nanofer, Czech Republic) was used and modified by two different polymers, chitosan (CS) and polyacrylic acid (PAA). The pristine nZVI stock solution (20 %wt.) was prepared by dispersion of nZVI powder in DI water under a nitrogen atmosphere in a DL 05 Laboratory Dispersion Unit (NANOIRON, CZ). Then, the nanoparticles were washed three times by DI water. Chitosan solution was prepared by mixing in acidified (nitric acid) DI water for 30 min until a clear mixture was obtained. The CS solution (2%) and nZVI (20%) were stirred in the nitrogen atmosphere of the DL 05, then washed three times in DI water. A similar procedure was followed to prepare the PAA-nZVI samples (without acidification). All samples were freeze-dried and stored in a desiccator.

Surface characteristics

The presence of both carbon and oxygen could be due to the polymer layer on the iron surface (Fig. 1). In the CS-nZVI high-resolution spectrum of Fe 2p four peaks ascribed to the oxidation state of iron could be observed, while at ~706 eV associated satellite peak could be attributed to Fe⁰ according to the literature. The small peak of Fe⁰ could be due to the core shell structure of these nanoparticles.

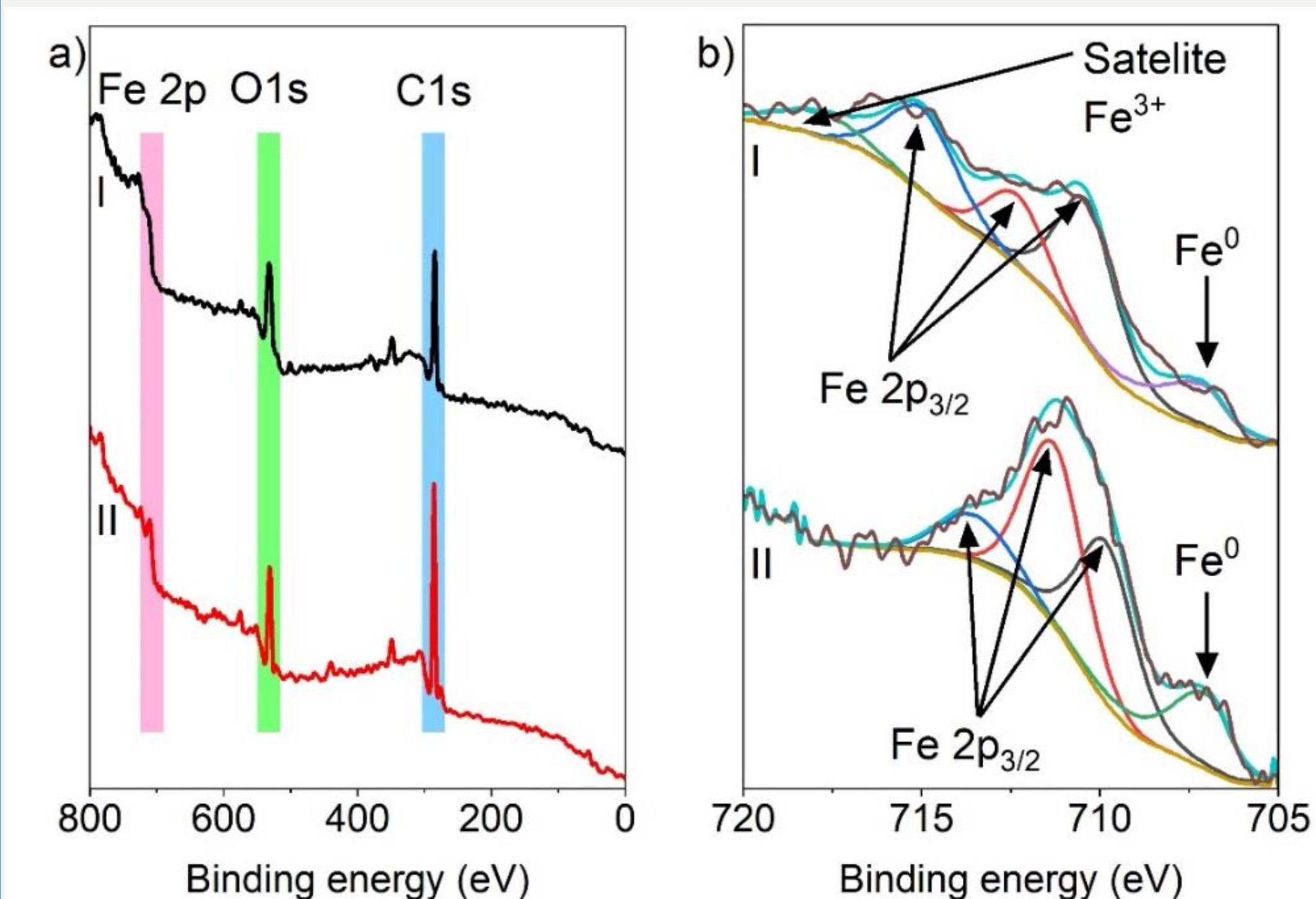


Fig. 1 a) Full-scale XPS spectrum of I) CS-nZVI and II) PAA-nZVI; b) Fe 2p XPS profiling spectra of I) CS-nZVI and II) PAA-nZVI.

Morphology and shape

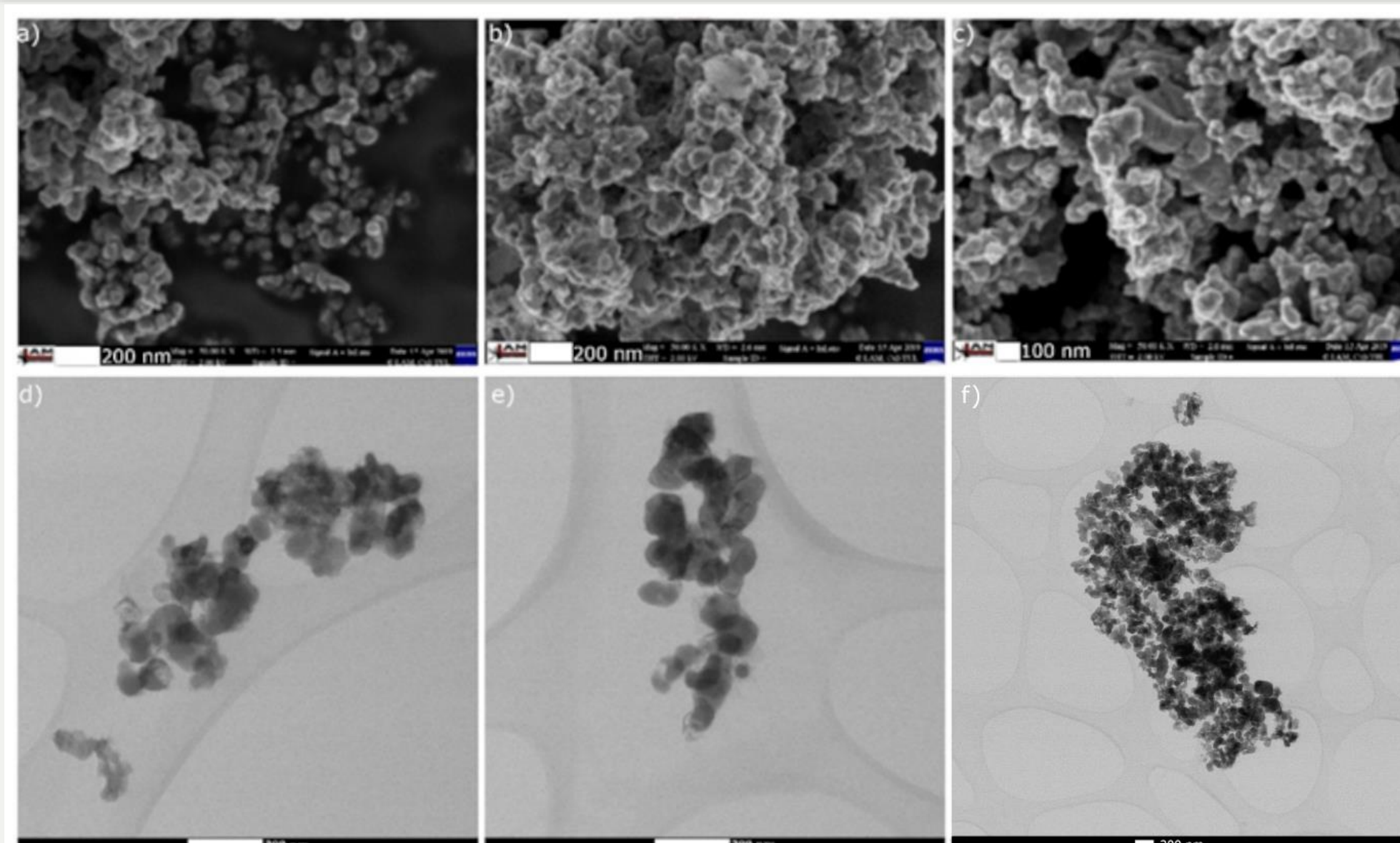


Fig. 2 SEM images of a) nZVI, b) CS-nZVI and c) PAA-nZVI, TEM images of d) nZVI, e) CS-nZVI and f) PAA-nZVI.

Zeta potential measurements

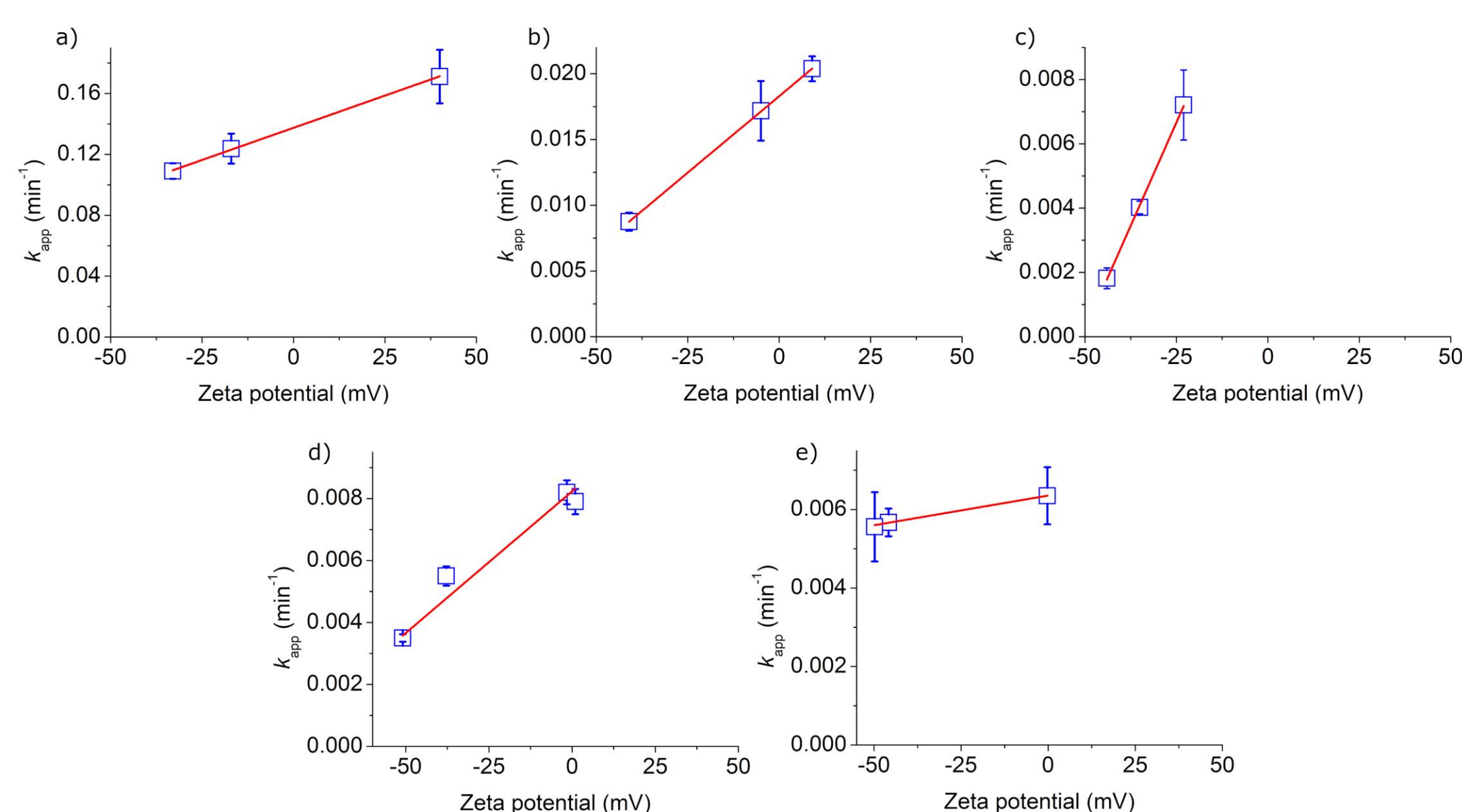


Fig. 3 The correlation between the zeta potential values of the nZVI and k_{app} of a) SMX b) MO, c) 4-NP oxidation, d) correlation between the zeta potential values of the GO/rGO and k_{app} of MO oxidation, and e) correlation between the zeta potential values of the FW 200 and k_{app} of MO oxidation (all reaction conditions are listed in the methodology section).

Conclusions

- To the best of our knowledge, the present article reports the close correlation between the zeta potential values of catalysts and the k_{app} of the oxidation of several organic compounds for the first time; and provides insights in the understanding of the heterogeneous activation of PDS.

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