Investigating high entropy nanoparticles as signal transducers in point-of-care lateral flow immunoassays

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Abstract

Lateral flow immunoassay is by far one of the most successful analytical platforms applied in point-of-care diagnostic test due to it simplicity, rapidity and cost effectiveness. It should be noticed that the treatment outcome can be significantly improved if the time of diagnosis is reduced.

In 2007, Fe_3O_4 nanoparticles were reported to possess peroxidase-like activity.[1] Later, a point-of-care test based on Fe_3O_4 nanoparticles was developed for rapid detection of Ebola virus.[2] It was also demonstrated that replacing Fe^{2+} ion by other ions (Co^{2+}, Mn^{2+}, Ni^{2+}, Zn^{2+}, Mg^{2+}, Cu^{2+})[3,4] allowed a tailored peroxidase-like activity or even offered a new enzyme-mimicking activity, e.g. catalase.

High entropy nanoparticles are defined as materials containing 5 or more metal cations with a maximized configurational entropy and have been extendedly studied as catalysts in energy-related areas. However, there is limited report of their utility in biomedical sciences.

In our research, several high entropy oxide nanoparticles were prepared by ball milling and their peroxidase-like activity was determined. It turned out that the samples did possess enzyme-like activity and some of them showed a higher activity, compared to reference Fe_3O_4 nanoparticles. Their catalytic activity depends on different metal compositions distributed in A sites and B sites of spinel structure. The materials displayed a better thermostability than native horseradish peroxidase. Furthermore, selective materials were bioconjugated with rabbit IgG antibody. The result showed that the conjugation step was successfully done and the conjugates preserved their activity in nELISA assay. This may suggest the potential of high entropy nanoparticles for lateral flow assay.

Figures

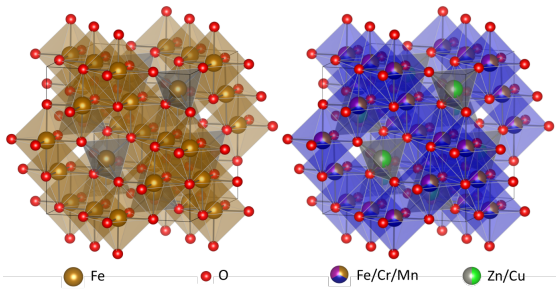

Figure 1. Crystal structure of Fe_3O_4 nanoparticles and high entropy oxide nanoparticles $(ZnCu)(FeCrMn)_2O_4$

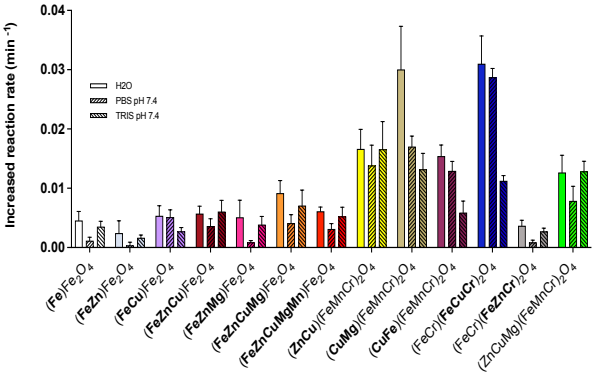

Figure 2. Catalytic activity towards TMB/H_2O_2 in different mediums

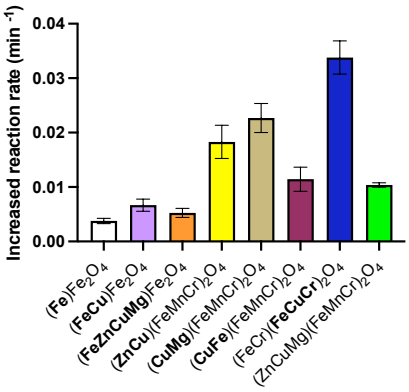

Figure 3. Catalytic activity of IgG conjugates in nELISA format

References

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diaminophenazine in the presence of cubic ferrites MFe2O4 (M = Mn, Co, Ni, Zn) and the application in colorimetric detection of H2O2. Appl Organomet Chem **32**, (2018).

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