SIIC049

COMPARATIVE STUDY OF SURFACE MODIFICATION ON REDOX PROPERTY OF CeO_2 AND CeO_2 BASED CATALYSTS

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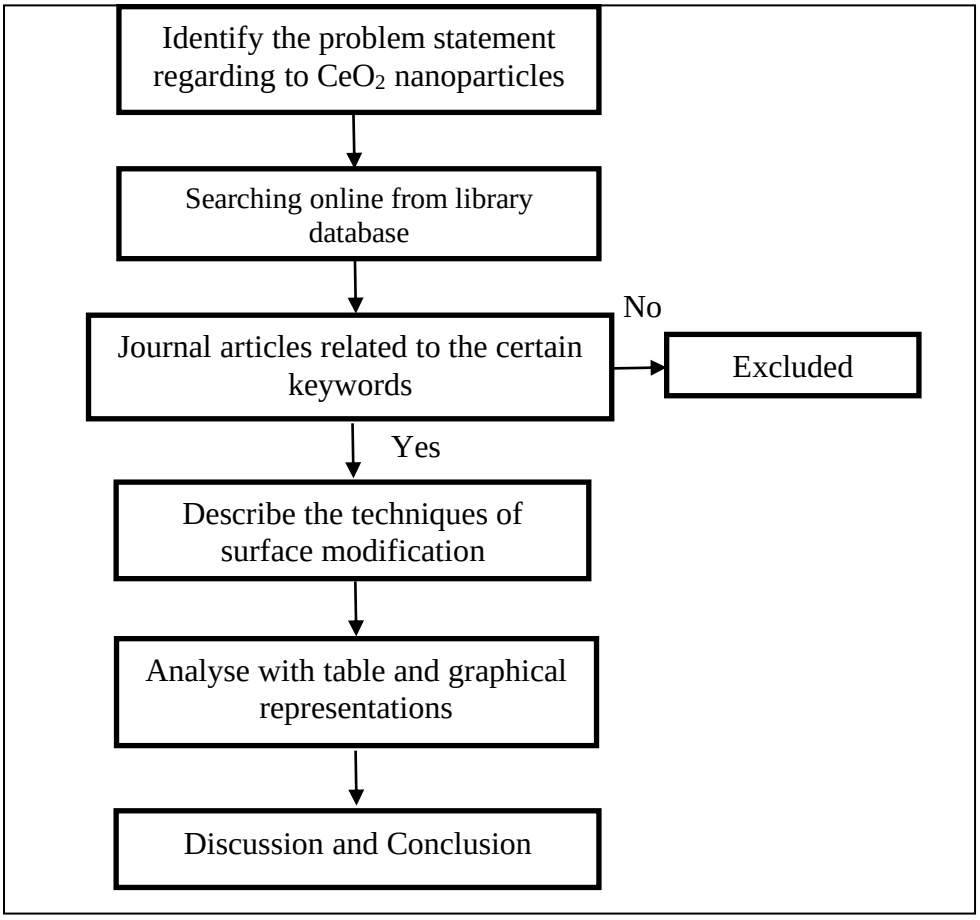
Abstract:
Cerium oxide (CeO_2) is used in a variety industrial applications process and CeO_2 based materials have been used in environmental applications due to its potential to reverse or block environmental damage and reduce the emission of toxic pollutant. The significant influences on CeO_2 performance depend on the surface properties of materials which can develop the transition between Ce^{3+} and Ce^{4+} ions. The controllable regulation on their surface features such as surface defects is an efficient approach to intensify their catalytic activity. The objective of this review study is to identify the best technique used to regulate the surface defects of CeO_2 catalysts based on its redox properties by referring several articles such as pressure regulations and annealing temperatures, chemical doping, and post-treatment. The results of measured oxygen storage capacity (OSC) from TPR and Ce^{3+} concentration from XPS analysis were analyzed. The existence of oxygen vacancies and their transportation in the crystal cell of CeO_2 is influential as it led to the generation of Ce^{3+} species. Thirteen articles were used as the main references to identify the measurement of OSC and Ce^{3+} concentration produced from those techniques. Based on the previous studies, the pressure regulations and annealing temperatures have increased the OSC measurement by 67.24% and 60.25%. For chemical doping technique, it showed that Ce^{3+} surface fraction had increased by 25.8%. The post-treatment technique had also increased the Ce^{3+} surface fraction by 13% in the presence of reducing/oxidizing agents. In conclusion, the comparison on relative measured OSC or Ce^{3+} surface fraction with catalytic efficiency for each technique has been done and it shows that the performance of the catalytic activity obtained the highest efficiency with 96.5% by using post-treatment compared to other techniques. Hence, the best technique to modify the surface of CeO_2 is post-treatment in the presence of reducing/oxidizing agents.

***Keywords*:**
Cerium oxide (CeO_2), Oxygen Storage Capacity (OSC), Ce^{3+} concentration; X-ray Photoelectron Spectrocopy (XPS); Temperature Program Reduction (TPR)

Objectives:

- To analyze the three methods used to regulate the surface modification of CeO_2
- To identify the best technique of surface modification of CeO_2 nanoparticles based on its redox properties

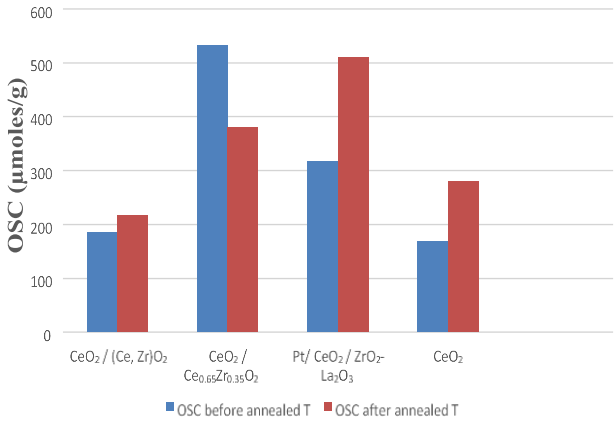
Methodology:



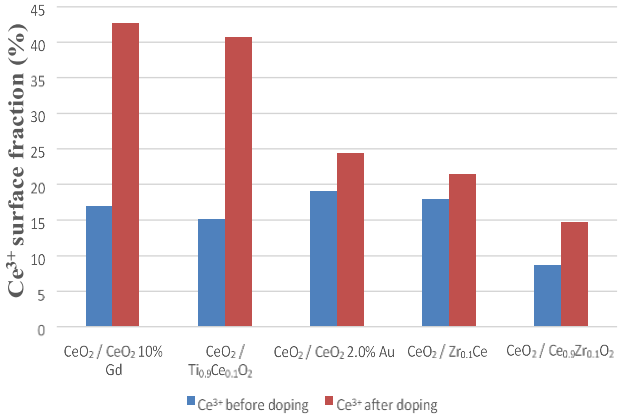
There are three techniques to regulate the surface defect of CeO_2 nanoparticles such as pressure regulations and annealing temperatures, chemical doping, and post-treatment. The annealing method is one of the techniques to modify the surface of CeO_2 by varies the temperature, pressure, and also gas atmosphere. This technique is used to modify the oxygen storage vacancy (OSC) of CeO_2 by Temperature Program Reduction (TPR) analysis. Another technique is by doping with other metal or metal oxides. This technique use to modify the Ce^{3+} concentration of CeO_2 by X-ray Photoelectron Spectroscopy (XPS) analysis. Last technique is post-treatment technique which is used to modify the Ce^{3+} concentration of CeO_2 by X-ray Photoelectron Spectroscopy (XPS) analysis. The comparison of three techniques has been done to achieve the target of this study which is to identify the best technique of surface modification of CeO_2 nanoparticles based on its redox properties. The highest relative measured OSC or Ce^{3+} concentration and its catalytic efficiency result from each technique will be select and a graph will be constructed to compare and identify the best technique of surface modification of CeO_2 nanoparticles.

Results:

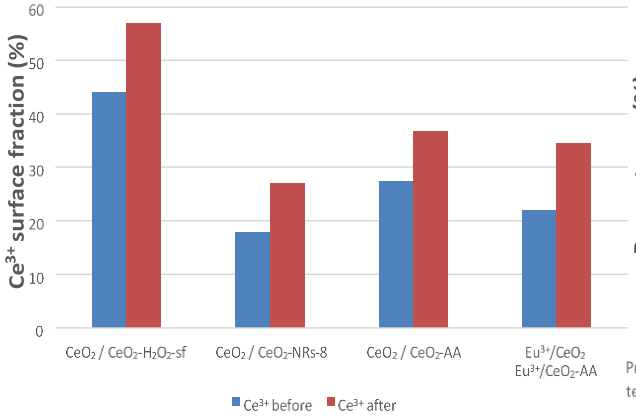
Annealing at different temperatures and pressures



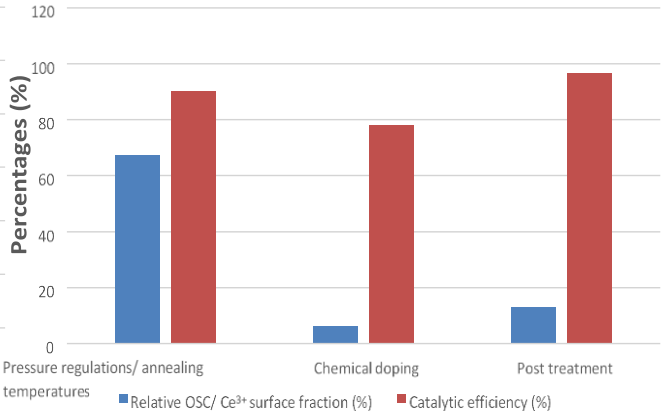
Chemical doping



Post-treatment



Comparison of the three techniques



Conclusion:

This review paper used to identify the best technique used to regulate the surface defects of CeO_2 catalysts such as pressure regulations and annealing temperatures, chemical doping, and post-treatment in the presence of oxidizing or reducing agents and its efficiency towards OSC and Ce^{3+} concentration of catalyst. The highest relative measure OSC or Ce^{3+} concentration and its catalytic efficiency result from each technique have been selected to compare and identify the best technique of surface modification of CeO_2 nanoparticles. Post-synthesis such as pressure regulations and annealing temperatures also chemical doping techniques have been found as a lack of effective approaches to continuously tuning and control the surface properties of CeO_2. Post-treatment in the presence of H_2O_2 and ascorbic acid (AA) can be concluded as the best technique of surface modification of CeO_2 nanoparticles based on its redox properties as the relative measured Ce^{3+} surface fraction and catalytic efficiency was the highest compared to other techniques with 13% and 96.5%, respectively.