1. Phase Transfer Catalysis
--- the conditions for forming a third liquid phase; techniques for reusing the catalysts via the reuse the third liquid phase; optimal operating conditions for synthesizing fine chemicals by tri-liquid-phase catalysis and catalyzed by the catalyst-rich liquid phase.

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\text{Organic phase: } \text{C}_2\text{H}_5\text{Br} \quad \text{C}_2\text{H}_6\text{OCH}_3 \\
\text{Third liquid phase: } \text{C}_2\text{H}_5\text{Br} + \text{PEG-NaOC}_2\text{H}_4 \rightarrow \text{C}_2\text{H}_6\text{OCH}_3 + \text{PEG-NaBr} \\
\text{Aqueous phase: } \text{NaBr} + \text{PEG-NaOC}_2\text{H}_4 \rightarrow \text{NaOC}_2\text{H}_3 + \text{PEG-NaBr} \\
\text{NaOH} + \text{PEG-NaOC}_2\text{H}_4 \rightarrow \text{NaOC}_2\text{H}_3 + \text{PEG-NaOH}
\]

2. Abatement of Air Pollutants by Nanocatalysts
--- searching for a high performance supported metal-oxide catalyst for the separate and simultaneous catalytic reduction of sulfur dioxide and nitric oxide.

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\text{SO}_2 + \text{Reducing agent} \rightarrow \text{S} + \text{H}_2\text{O}, \text{COS}, \text{CO}_2 \\
\text{NO} + \text{Reducing agent} \rightarrow \text{N}_2 + \text{H}_2\text{O}, \text{CO}_2 \\
\text{[ Reducing agent: } \text{H}_2, \text{CO}, \text{CH}_4, \text{C}_2\text{H}_4 \text{ ]}
\]

We can find an optimal condition for forming the third liquid phase in which almost all catalyst resides, so the catalyst in the third liquid phase can be used repeatedly. In addition, because the density of this phase is in between those of the organic and aqueous phases, when the tri-liquid phase catalysis is carried out in a continuous-flow tank reactor, the third liquid phase will not flow out from the reactor, and the catalyst can be used continuously.
3. Mesoporous Sulfated Zirconia
   --- finding a suitable method for preparing the catalyst and its application to esterification, alkylation and isomerization.

   --- improving the performance of the catalyst layer by searching for a suitable preparation method and finding a proper carbon support.

5. Photocatalysis
   --- searching for the high activity catalysts and designing reactors for water splitting and mitigation of carbon dioxide with water and hydrogen as reducing agents.

   photocatalysts
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   \text{CO}_2 + \text{H}_2\text{O or } \text{H}_2 \rightarrow \text{CH}_4, \text{CH}_3\text{OH, HCHO}, \ldots
   \]

Selected Publications
2. Chi, CF; Lee, YL; Weng, HS, A CdS-modified TiO2 nanocrystalline photoanode for efficient hydrogen generation by visible light,: NANOTECHNOLOGY Volume: 19 Issue: 12 Article Number: 125704 , 2008