On the role of colloidal particles on the base catalyzed etherification of glycerol

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Glycerol is a side product of the bio-oils industry. Due to the increasing biodiesel production, the supply of glycerol is also predicted to increase significantly. It can be used as an attractive renewable building block, e.g. it can be etherified to obtain di- and triglycerols, which have numerous applications in cosmetic and pharmaceutical industries.

Basic catalysts are known to catalyze this reaction. In the current work, we have explored the catalytic potential of alkaline earth oxides, concentrating on CaO-based catalysts as environmentally friendly materials with low toxicity and high catalytic performance. \cite{1}

We found out that basicity is not the only factor that decides on the catalytic properties. The highest conversion was observed for materials, that possesses high basicity, high surface area and the highest Lewis acidity. We postulate a reaction mechanism, according to which not only the basic sites participate in the reaction, but also the Lewis acid sites (associated with coordinatively unsaturated Ca atoms).

In order to explain in more detail the behavior of these catalyst systems, we examined them in connection with the reaction environment in which they work, as partial hydration of the catalytic materials during the process can lead to the formation of Ca(OH)\textsubscript{2} colloids.

At the beginning of the reaction an ‘activation period’ was observed, after which the conversion sharply increased. We presumed this initial period to result from the formation of colloidal particles. The largest amount of colloids was generated in the case of a catalyst, which had the shortest activation period and the highest activity.

The nature of the glycerol phase was investigated by light scattering measurements as well as cryo-TEM and the presence of \textit{in-situ} generated colloids (Fig. 1) was proven by these techniques. The sub-micrometer size of those particles accounts for their very high catalytic activity.

Those colloidal particles were isolated and in the separate catalytic experiments their very high activity was confirmed. Understanding the nature of these Ca-based colloids opens new opportunities for investigations of supported colloidal catalysts to take advantage of both their hetero- and homogeneous nature and prepare novel catalysts with even better performance.

\begin{figure}[h]
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\includegraphics[width=0.5\textwidth]{figure1.png}
\caption{Cryo-TEM images of colloids generated from CaO material.}
\end{figure}

References:

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