CHAPTER 1: INTRODUCTION TO THE SUPPORTED REAGENTS

The supported reagents make life considerably easier for a preparative chemist. Although the subject of supported reagents chemistry can be traced back to 1924, reports on use of chemical reagents on porous carriers to achieve some “highly selective and mild operations,” the subject has only truly blossomed in the last 25 years. Heterogenous organic reactions effected by reagents immobilized on porous solids are useful to chemists involved with laboratory and manufacturing scale synthesis.

There are number of advantages of the supported reagents such as selectivity, activity, environmentally acceptability. In most of the cases the reactions take place under mild conditions. Good dispersion of active sites can lead to significant improvements in reactivity. The supported reagent is easy to remove from final reaction mixture, hence minimising cross contamination between organic and inorganic components. Some supported reagents may be recycled and reused. The functionalised polymers are used both as reagents and as catalysts.

In this chapter we attempt to present a review on solid supported reagents in organic synthesis, their preparation, characterization and applications to various types of organic transformations.

CHAPTER 2: APPLICATIONS OF ENVIROCATS IN ORGANIC SYNTHESIS

Envirocats is a new family of solid supported environmentally friendly reagents capable of catalysing number reactions. Some important reactions catalysed by these reagents are studied. This chapter deals with applications of these reagents for Transesterification and Transthiolesterification (Section I) and Friedel Craft’s acylation (Section II).

Section I: Transesterification and Transthiolesterification.
The selective transesterification of β-ketoesters is carried out by using envirocat EPZG as a catalyst. The various alcohols applied for this transformation such as primary, secondary, tertiary, allylic, benzylic and propargylic. (Scheme I)
Scheme 1

\[
\begin{align*}
\text{Scheme 1} \\
\text{1} + \text{ROH} \xrightarrow[\text{Toluene/\Delta}]{\text{EPZG}} \text{2} + \text{MeOH} \\
\text{3} + \text{ROH} \xrightarrow[\text{Toluene/\Delta}]{\text{EPZG}} \text{4} + \text{EtOH}
\end{align*}
\]

The transthiolesterification, having very few reports in the literature, was also successfully carried out using this eco-friendly catalyst envirocat EPZG (Scheme II).

Scheme 2

\[
\begin{align*}
\text{Scheme 2} \\
\text{1} + \text{RSH} \xrightarrow[\text{Toluene/\Delta}]{\text{EPZG}} \text{5} + \text{MeOH}
\end{align*}
\]

The chemoselectivity towards transesterification of alcohols, thiols, and amines is also studied (Scheme III).

Scheme III

\[
\begin{align*}
\text{Scheme III} \\
\text{1} + \text{HOO} \xrightarrow[\text{EPZG/Toluene/\Delta}]{\text{i}} \text{6} \\
\text{1} + \text{HO-SH} \xrightarrow[\text{EPZG/Toluene/\Delta}]{\text{i}} \text{7} + \text{8} \\
\text{1} + \text{HOO-H} \xrightarrow[\text{EPZG/Toluene/\Delta}]{\text{i}} \text{9}
\end{align*}
\]

i = EPZG/Toluene/\Delta
All these reactions are found to be successful when \( \beta \)-ketoesters are subjected for the reaction. Attempts to carry out transesterification of simple esters were failed using this method.

**Section II: Friedel Crafts Acylation**

The effective Friedel-Crafts acylation of anisole using benzoic acids is described. The smooth reaction of the anisole moiety with aromatic acids along with catalytic amount of enirocat EPIC was successful (Scheme IV). The important feature of this method is that aromatic acids having electron donating substituents were able to undergo reaction, whereas those with electron withdrawing substituents failed to undergo this reaction. The catalyst, Natural Kaolinitic Clay was also tried for similar transformation, but found to be unsuccessful. When acid chlorides were used instead of acids the reaction was comparatively fast, yielding ketones in good to excellent yields (Scheme V). \( \text{para} \) selectivity is the important feature of this protocol.

**Scheme IV**

![Scheme IV](image)

**Scheme V**

![Scheme V](image)

The same methodology is extended for the sulfonylation of aromatic moieties yielding sulfones in good yields under these reaction conditions (Scheme VI). The protocol allows the sulfonylation selectively at \( \text{para} \) position.
R= alkyl, aryl, halogen etc.  
N.C.= Natural Kaolinitic Clay

CHAPTER 3: SOLVENT FREE ORGANIC SYNTHESIS USING MICROWAVES AND SUPPORTED REAGENTS

Microwave induced organic reactions under solvent free conditions using supported reagents is the field of interest of most of the organic chemists now a days. The reactions are clean and most of these do not require solvents and thus make the protocol economically attractive and environmentally benign.

The various reactions studied include the synthesis of imines and enamines using envirolcat EPZ10 (Scheme VII).

Scheme VII

| R=--NO_2,--OH,--OCH_3 etc. | R'=--NO_2,--OH,--OCH_3, Halogen, etc. |

The selective iodination of benzylic alcohols to corresponding iodides was also carried out using conc. H_2SO_4 and KI impregnated on natural kaolinitic clay. (Scheme VIII)
Efficient transformation of aldoximes to nitriles was also carried out using various solid supported catalysts such as natural clay, EPZG, EPIC, EPZ10 (Scheme IX).

Scheme IX

\[
\begin{array}{c}
\text{X} \quad \text{CH=N-OH} \\
\text{25} \quad \text{Catalyst} \\
\text{MW} \\
\rightarrow \\
\text{X} \quad \text{C=N} \\
\text{26}
\end{array}
\]

\(X=\overset{\text{OCH3}, \text{NO2}, \text{Cl}, \text{OH etc.}}{\text{etc.}}\)

Facile deprotection of THP ethers with EPZG and drop of water under MW was also studied and it is important to noteworthy that various other sensitive functional groups remain intact during deprotection of THP ethers (Scheme X).

Scheme X

\[
\begin{array}{c}
\text{R-OH} \\
\text{27} \quad \text{EPZG/H}_{2}\text{O} \\
\text{MW} \\
\rightarrow \\
\text{R-OH} \\
\text{28}
\end{array}
\]

CHAPTER 4: POLYMER SUPPORTED REAGENTS IN ORGANIC SYNTHESIS

Polymer supported reagents are important in organic synthesis due to their selectivity and ease of work-up. Functionalised polymers are used both as reagents and as catalyst. Polymer supported reagent is a reactive organic group bound to a macromolecular support and used in stoichiometric quantities to achieve the chemical modification. This chapter deals with the application of polymer supported reagents for rapid synthesis of thiols (Section I) diethyl dithiocarbamates (section II) and disulfides (Section III).

Section I: Rapid Synthesis of Thiols

Thiols are prepared in high yields from corresponding alcohols using \(\text{PPh}_3\), NBS in acetone followed by addition of polymer supported hydrosulfide under mild conditions (Scheme XI). This method produces thiols without trace of dialkyl sulfides.

Scheme XI

\[
\begin{array}{c}
\text{R-OH} \\
\text{28} \quad \text{PPh}_3\text{,NBS} \\
\text{acetone} \rightarrow \text{10 }^\circ\text{C} \\
\rightarrow \\
\text{R-SH} \\
\text{29}
\end{array}
\]

\(R=\text{alkyl, aryl alkyl.}\)
The thiols were also prepared from alcohols via their trifluoroacetates using polymer supported hydrosulfide under mild conditions (Scheme XII).

Scheme XII

\[
\begin{align*}
R\text{-OH} & \xrightarrow{(CF_3CO)_2O} R\text{-SH} \\
\text{28} & \text{acetonitrile} \\
\text{29} & \\
R & = \text{alkyl, aryl alkyl.}
\end{align*}
\]

Section II: Synthesis of Diethyl dithiocarbamates

Due to low solubility of diethyl dithiocarbamate metal salts in organic solvents, the alkylation of these compounds is difficult, requiring drastic conditions which cause decomposition resulting in low yields of products. The polymer supported diethyl dithiocarbamate was successfully alkylated and arylated using alkyl and aryl halides and aryl diazonium fluoroborates (Scheme XIII).

Scheme XIII

\[
\begin{align*}
R\text{-X} & \xrightarrow{\text{acetonitrile, r.t.}} R\text{-S-p-NEt} \\
\text{30} & \\
R & = \text{alkyl, aryl, aryl alkyl} \\
X & = \text{Halogen, } \text{-N}_2\text{BF}_4
\end{align*}
\]

The alkylation of diethyl dithiocarbamate was also carried out with alcohols via their trifluoroacetates under mild conditions and in good yields (Scheme XIV).

Scheme XIV

\[
\begin{align*}
R\text{-OH} & \xrightarrow{(CF_3CO)_2O} R\text{-S-p-NEt} \\
\text{28} & \text{acetonitrile, r.t.} \\
\text{31} & \\
R & = \text{alkyl, aryl alkyl}
\end{align*}
\]

Section III: Synthesis of Disulfides

This section deals with synthesis of disulfides from alkyl halides using polymer.
supported sulfurated borohydride. The reaction was spontaneous yielding the disulfides in good to excellent yields (Scheme XV).

Scheme XV

\[
\begin{align*}
R-X & \quad \xrightarrow{\text{SBER, MeOH, 25 °C}} \quad R-S-S-R \\
_{30} & \quad \quad \quad \quad \quad \quad _{32}
\end{align*}
\]

\(R=\text{alkyl, aryl alkyl}\)