

CHAPTER I

Introduction

Growing environmental consciousness has motivated the chemists around the world to search for environment benign solvents, non-polluting media for chemical synthesis as alternatives to the conventional volatile organic solvents. Chemical reactions generally depend on three conditions: solvent, reaction temperature and atmosphere. Among these conditions, a chemist can easily optimize the solvent system for a particular reaction keeping in view: i) solubility of the reactants, ii) reaction temperature and pressure, iii) product separation and purification, *etc.* The majority of solvents that used in academic and industrial laboratories are molecular liquids belong to the group of volatile organic compounds (VOC). These solvents are responsible for a large number of environmental problems and have a great impact on cost, safety and health. Furthermore, recovery and reuse of these chemicals are often associated with energy-intensive distillation and sometimes contamination. In the past few decades there have been numerous advances in synthetic organic methodologies that bypass the use of hazardous chemicals or VOC as solvents. Research in different chemical fields has led to search substitutes for toxic organic solvents and has proposed ionic liquids (ILs) as alternative solvents. Ionic liquids are almost identical with conventional molecular solvents, particularly in showing unique solubility against organic and inorganic materials. The interesting feature of ILs is that their formulations can be tailored at the molecular level by selection of desired constituent ions. ILs are now widely known solvents for different organic transformations and offer possibilities for improvement in the control of product distribution, enhanced reactivity, ease of product recovery, catalyst immobilization and recycling, *etc.*

1.1. Ionic Liquids (ILs)

Ionic liquids are defined as organic salts that are typically composed of a large, asymmetric organic cation associated with an organic or inorganic counter anion and melt below 100 °C [1-3]. They are considered as nonaqueous green solvents or neoteric solvents and have drawn much attention worldwide. The interesting feature, *i.e.*, tenability of their physical and chemical properties by variation of ions makes these materials with almost unlimited possibilities, especially

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when considering an estimation of approximately 10^6 possible combinations of known cations and anions to form ionic liquids [4]. Typical IL cations are nitrogen containing such moieties such as alkylammonium, N,N' -dialkylimidazolium and N -alkylpyridinium or phosphorous containing moieties such as alkylphosphonium. The common anions may include halides, BF_4^- , PF_6^- , CH_3CO_2^- , CF_3CO_2^- , NO_3^- , $[(\text{CF}_3\text{SO}_2)_2\text{N}]^-$, *etc.* Some of the typical cations and anions used for the synthesis of ionic liquids are illustrated in Fig 1.1.

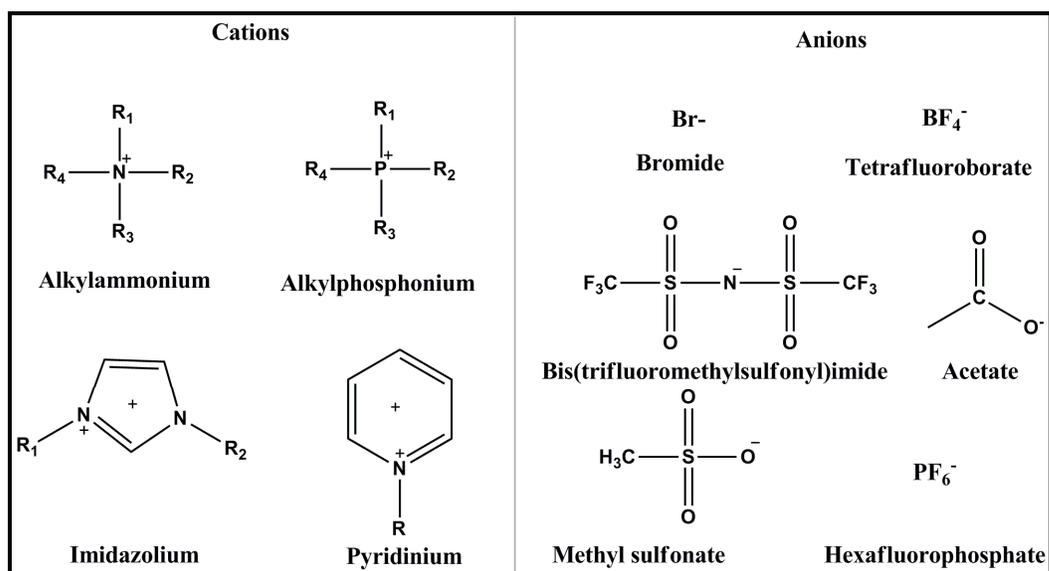


Fig 1.1. Some of the typical anions and cations used in ionic liquids preparation.

Ionic liquids have led to a new green chemical revolution owing to their unique physico-chemical properties [5, 6] such as: i) They have very low vapor pressure, low flammability and high ionic conductivity, ii) ILs possess an extensively wide temperature range of liquid state, so they are thermally stable and are applicable to reactions under high thermal conditions, iii) ILs can dissolve a large number of organic and inorganic materials and behave as highly polar aprotic solvent, iv) Most of the ILs exhibit limited or no toxicity. Due to these unique features, ILs are widely employed as solvents or reagents in a variety of applications like organic catalysis [7-11], inorganic synthesis [12], biocatalysis [13-18], polymerization [19, 20] and engineering fluids [21-22] *etc.* Another important property of ILs is observed in the versatility of their design. Chemical modification of the structure of ILs can be

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tailored for a specific application. Due to this flexibility in structure modifications they have recently been investigated as solvents or materials for different pharmaceutical applications too [23-25]. Imidazolium-based ionic liquids are an important class of ILs among all the types of ionic liquids [26-28]. Their negligible vapor pressure allows their use to detect the size and shape of metal nanoparticles (NPs) through *in situ* X-ray photoelectron spectroscopy (XPS) or transmission electron microscopy (TEM) analyses [29, 30]. The supramolecular three-dimensional structural arrangement of imidazolium based ILs has a direct impact on their physicochemical properties and assists to illustrate their influence over several organic transformations [31]. Another remarkable property of these imidazolium-based ILs is their ability to dissolve large number of organic and inorganic compounds independently because of their polarities. This is due to their natural segregation in two main domains: polar and non-polar [32]. As a result, polar substrates are preferentially dissolved in polar domains and *vice versa* [33-37]. The synthesis of ILs can generally be divided into two steps: first the formation of the desired cation and then anion exchange or metathesis. 1-methylimidazole is generally required for the preparation of imidazolium based ionic liquids. This is readily available at a reasonable cost from commercial sources and provides access to a large number of cations. Other N-substituted imidazoles are relatively expensive. 1-alkylimidazole can be synthesized easily in the laboratory [38] by refluxing imidazole with alkyl halide at 80 °C. A scheme is illustrated in Fig 1.2

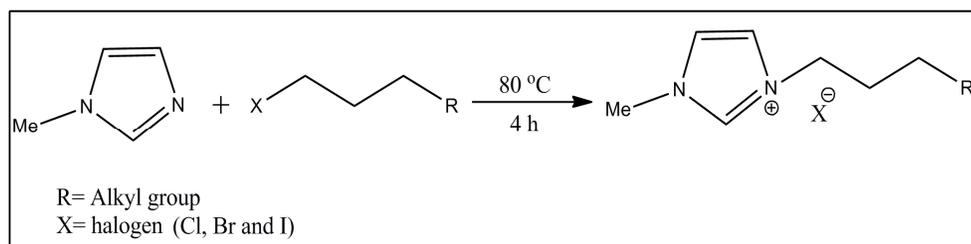


Fig 1.2. Synthesis of imidazolium salt from alkyl halide

The anion exchange reaction is usually performed in suitable organic solvents [39]. This process was reported to give good yields and applied to synthesize various ILs containing a wide variety of anions like PF_6^- , BF_4^- , SbF_6^- , $[\text{CF}_3\text{SO}_3]^-$, $[\text{CF}_3\text{SO}_2]^-$ and

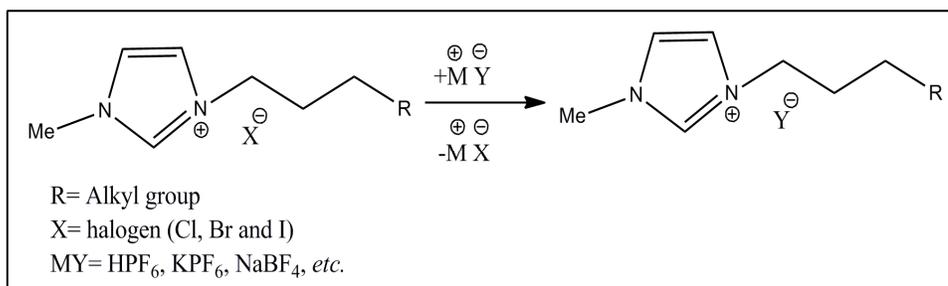


Fig 1.3. Metathesis reaction of imidazolium moiety.

(CF₃SO₂)₂N⁻, etc. The anion exchange reaction of the imidazolium moiety is illustrated in Fig 1.3. The lack of significant vapor pressure prevents the purification of ILs by distillation. Actually volatile impurities can be separated from ionic liquids by distillation. It is suggested to remove the impurities from the starting materials and to apply such synthetic process that generates few side products [39, 40]. Most of the ILs based on common cations and anions are colorless. But it is observed the products are often yellow colored, particularly during the quaternization step. The amount of impurity making this color is extremely small, often being undetectable in ¹H-NMR or CHN microanalysis.

1.2. Functionalized ionic liquids [FILs]

Functionalized ionic liquids (FILs) may be defined as ionic liquids in which a functional group such as hydroxyl, amino, sulfonic acid or carboxyl group and so on is introduced to the cation or anion (mostly cation) of the ILs [41]. The incorporation of this functionality makes the compound with a capacity to behave not only as a reaction medium but also as a reagent or catalyst for different chemical reactions [42, 43]. Conceptually, the functionalized ion is considered as possessing two elements. The first is a core that contains the ionic charge and acts as the locus for the second element, *i.e.*, the substituent group. In most of the cases, it is observed that the functional group of the FILs is cation-tethered. The FILs usually display similar physicochemical properties to those observed in case of pure ILs.

1.2.1. Functionalized Cations

Although, the FILs are defined as ionic liquids in which functional group is incorporated to the cations or anions (or both) of the IL, subsequent research has focused on the introduction of functionality into the cations [44]. The most of the

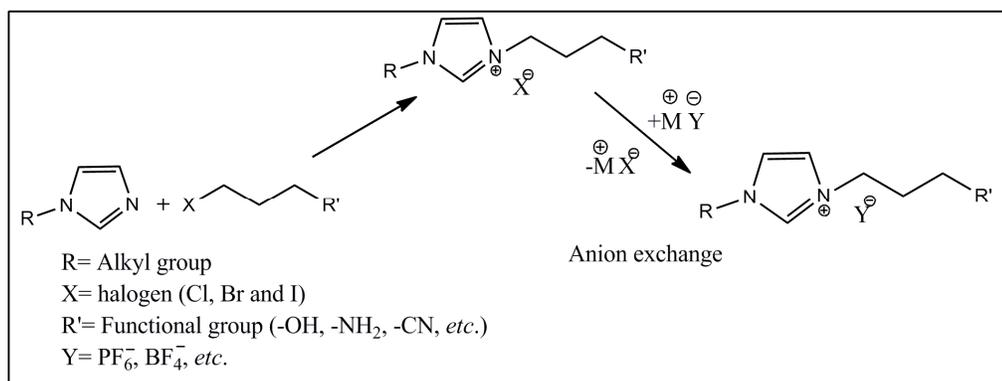


Fig 1.4. Synthesis of task specific ionic liquids

FILs have been prepared by quaternization of the imidazoles with a functionalized alkyl halide to afford the corresponding functionalized imidazolium halides in usually good yield [45]. General synthesis of FILs with functionalized cations from 1-alkylimidazoles is illustrated in Fig 1.4. FILs are designed to extract metal ions from an aqueous solution. While certain FILs have been developed to pull metals into the IL phase. The use of metal complexes dissolved in ionic liquids for catalytic reactions has been an interesting field of ionic liquid research to date. Still, this system has a tendency to leach dissolved catalyst into the co-solvents that are employed to extract the product of the reaction from the ionic liquid [46-48]. Some mono-functionalized cations and their field of applications [49, 50] are represented in Fig 1.5.

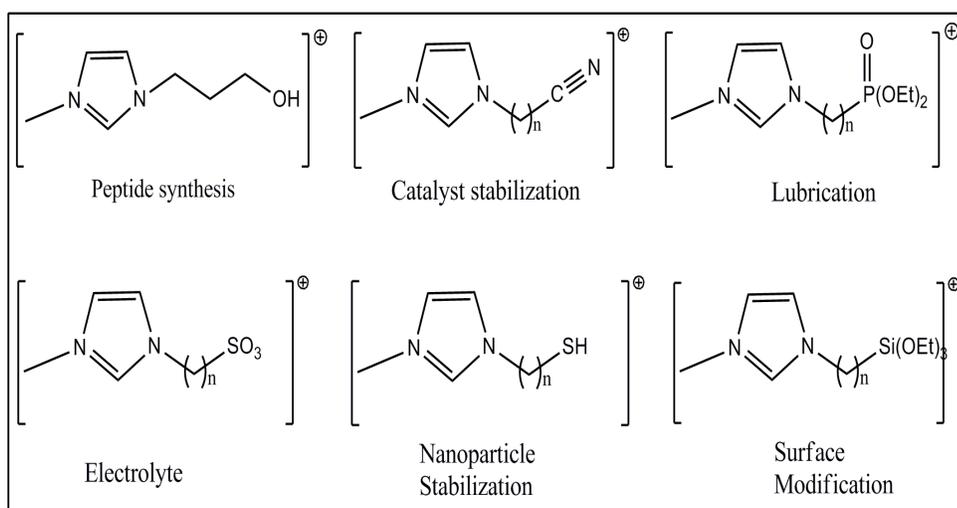


Fig 1.5. Mono-functionalized imidazolium cations and their potential applications.

1.2.2. Functionalized Anions

It is observed, compared to the FILs with functionalized cations, much less interest has been shown to the synthesis of ionic liquid systems with functionalized anions. Some examples with their potential applications [49] are shown in Fig 1.6.

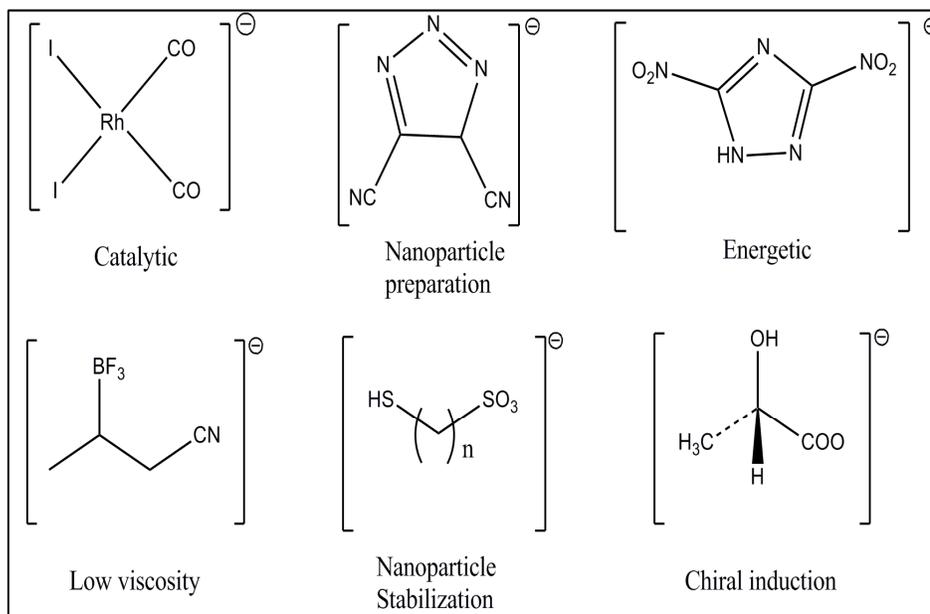


Fig 1.6. Functionalized anions and their potential applications.

Although some of the important applications of FILs have been highlighted in Fig 1.5 and 1.6, they have potential catalytic applications which has attracted the researchers worldwide to continue work in this field. Furthermore, these ILs often play a decisive role in the synthesis of nanoparticles and nanostructures as particle stabilizing agents. Hence, ILs are usually considered as to be highly polar, yet, often weakly coordinating solvents. Solvatochromatic investigation reveals that ionic liquids have properties similar to those of small-chain alcohols and other polar, aprotic solvents (DMSO, DMF, *etc.*) [51-53]. So, their polarity is intermediate between water and chlorinated organic solvents and varies within the region depending on the nature of the IL components. By changing the nature of the ions present in ionic liquids, the properties of the ionic liquids can be altered. For example, the solubility of water in ILs can be changed from complete miscibility to almost total immiscibility, tailoring the anions from Cl^- and PF_6^- . ILs are found to be immiscible with alkanes and other non-polar organic solvents and hence can be used in two-phase systems. Similarly,

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hydrophobic ILs can be designed and used in aqueous/IL biphasic systems. They are alternatives to the conventional organic solvents in liquid/liquid separation [54-56]. From the synthetic perspective the important features of an ionic liquid are: i) catalyst solubility, catalyst activity, immobilization to extraction processes; ii) reagent solubility and iii) product extractability.

Solubility of metal ions in ILs can be divided into processes involving the dissolution of sample metal salts, often through coordination with anions from the ionic liquid and the dissolution of metal coordination complexes in which the metal coordination remains unaffected. Simple metal compounds are poorly soluble in non-coordinating ILs. Addition of lipophilic ligands enhances the solubility of metal ions in ionic liquids. Ionic complexes are observed to be more soluble in ILs than the neutral complexes. Transition metal salts and complexes are used as homogeneous catalyst in ionic liquid systems [57-60]. ILs have also been used as inert additives to stabilize transition metal catalyst in an organic solvent systems [61, 62]. The extremely low solubility of ionic liquid component solubilizes the catalyst upon concentration and removal of organic solvent and product. By this way, ILs preventing catalyst decomposition and enabling recycling and reuse of catalyst in batch processes [63, 64].

On the contrary, the biological properties of ILs are dependent on both their cations and anions. Usually ILs, with long alkyl substituents, exhibit anti-microbial activity and weak mutagenic properties towards plants. It is seen that large numbers of ionic liquids exhibited no significant toxicity for animals [65]. In addition, ILs have many favorable features to replace organic solvents for the formation of pharmaceutical compounds. They often led to higher yields, better selectivity and simple product isolation. The reaction process involving ionic liquids may be homogeneous or heterogeneous phases, providing a higher flexibility in manipulating the reactions. ILs are preferable for both chemical and enzymatic synthesis of drug molecules [66-75].

1.3. Schiff Bases

Schiff bases are termed as “privileged” ligand due to their simple synthesis procedures and vast range of applications in different field [76]. These organic compounds are very much available, versatile and based on the characteristics of

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precursors they show different denticities and functionalities. The nature, number and relative position of the donor sites of a Schiff base permit a good control over the geometry of the metallic centers. Owing to the structural diversity and preparative accessibility they play essential roles both in the synthetic and structural research [77]. Most of the Schiff bases and their corresponding metal complexes have been investigated owing to their important and attracting properties, such as, their ability to bind oxygen, photo chromatic properties, catalytic activity in hydrogenation of olefins and complexing capability towards toxic metals [78-82]. Schiff bases play a vital role in the enzymatic or unenzymatic transminating reactions of the carbonyl compounds with amino acid [83]. They also provide options for generating substrate chirality and increasing the solubility and stability of homogeneous and heterogeneous catalyst [84]. Furthermore, Schiff bases are considerably used in medicinal and pharmaceutical field. The presence of toxophoric linkage (*i.e.*, -HC=N- linkage) in the structure allows them to show biological applications including antibacterial [85, 86], antifungal [87] and antitumor activity [88].

Schiff bases are organic materials containing azomethine linkage (-HC=N-) generally formed by condensation of the primary amines with a carbonyl compound [89, 90]. Hugo Schiff in 1864 first reported this organic compound [91]. The common structural property of Schiff bases is presence of the azomethine group in their structure, with the general formula $RHC=N-R'$ (where R and R' are alkyl, aryl, cycloalkyl or heterocyclic groups). The common synthetic path of synthesis of Schiff bases is mentioned in Fig 1.7.

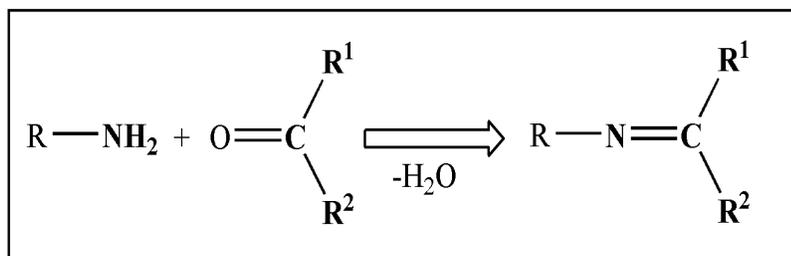


Fig 1.7. Synthesis of Schiff base from amine and carbonyl precursor.

Like aldehydes, ketones may be used in the synthesis of Schiff bases although ketones produce these compounds less readily than aldehydes. Furthermore, Schiff bases derived from the aliphatic aldehydes are less stable and easily polymerize [92]. The

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aromatic aldehydes having potent conjugated systems are more stable. The lone pair of electrons on the sp^2 hybrid orbital of nitrogen atom of azomethine linkage has substantial chemical and biological significance [93] and exhibit excellent chelating capability, when applied incorporation with one or more donor atoms adjoining to the azomethine linkage. The coordination nature of the Schiff bases depends on the carbonyl and amine molecules employed in condensation reaction. They may behave as bi-, tri-, tetra-, penta- or polydentate ligand based on the number of donor atoms present in the particular structure. Examples are given in Fig 1.8.

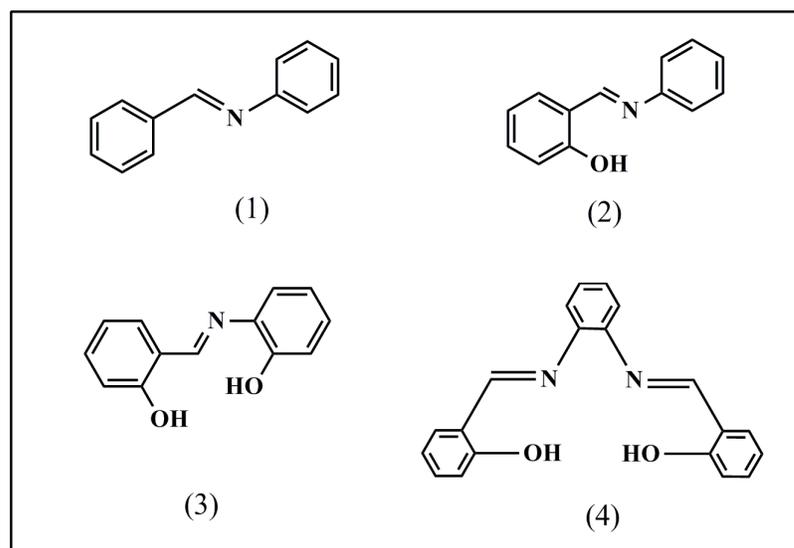


Fig 1.8. Schiff bases with mono-, bi-, tri- and tetra donor atoms.

Salicylaldehyde and its derivatives are most applicable carbonyl precursors for the preparation of a wide variety of Schiff bases [94, 95]. Now a days extensive research is going on the modification of Schiff base ligand to extend their applications in the area of synthesis and catalysis. Ionic liquid-supported Schiff base ligand is the results of such modification, where amine functionalized ionic liquids are condensed with aromatic aldehydes [96]. Formation of Ionic liquid-supported Schiff bases is represented in Fig 1.9.

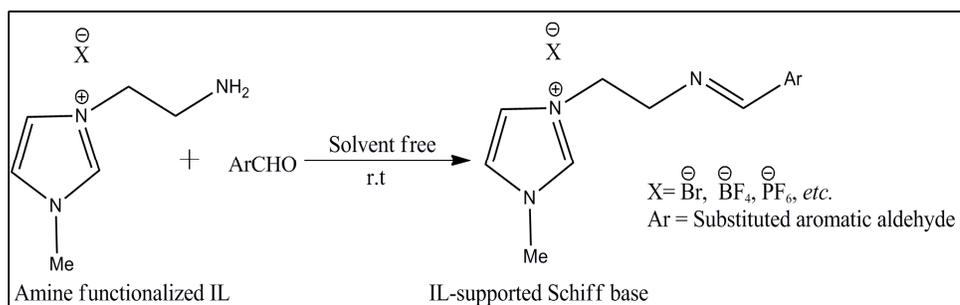


Fig 1.9. Synthesis of Ionic liquid-supported Schiff bases.

Ionic liquid-supported Schiff bases are found to be most convenient and attractive ligand for the forming of complexes with different metal ions owing to some important reasons. Mainly, steric and electronic consequences around the metal centre can be finely altered by a suitable selection of bulky or electron donating or withdrawing substituent included into the Schiff bases [97]. Again, the donor sites (N and O) of the coordinated Schiff bases show two opposite electronic effects: the phenolate oxygen atom is hard donor and stabilizes the higher oxidation states of the metal atom; whereas the imine nitrogen atom is borderline donor and stabilizes the lower oxidation state of the corresponding metal ion [98]. Their basicity also exhibits a vital role in the synthesis and stabilization of the complexes. The functional groups such as $-\text{OH}$ and $-\text{SH}$, available in the Schiff bases can generate tautomerism in them leading to complexes with various geometries. The keto-enol tautomerism of Ionic liquid-supported Schiff base is shown in Fig 1.10.

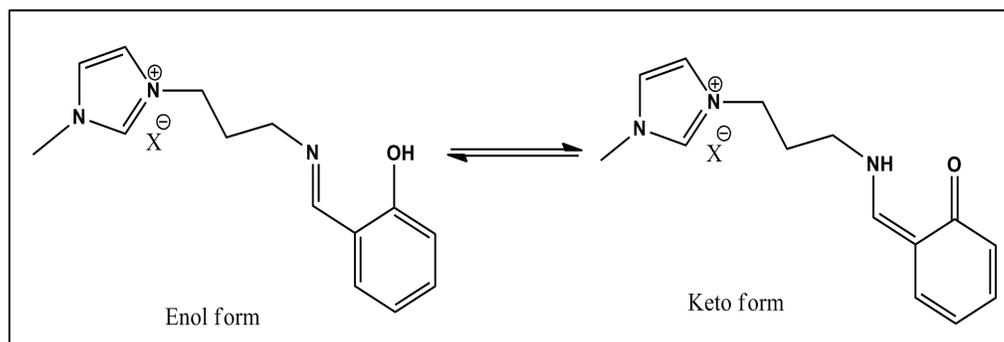


Fig 1.10. Keto-enol tautomerism of IL-supported Schiff base.

Ionic liquid-supported Schiff bases have vast range of applications in synthetic, catalytic and biological field. They are used to make suitable air stable and water

soluble catalyst for various types of organic transformations to establish methodology for C-C coupling reactions [99]. These novel Schiff base ligands are also applied in the metal catalyzed coupling reactions to get excellent yields [100, 101]. Furthermore, they are designed for the binding of metal ions from aqueous solutions. Example of such kind of Schiff base [5] applied in the extraction of Ni^{2+} ion from aqueous solution is shown in Fig 1.11.

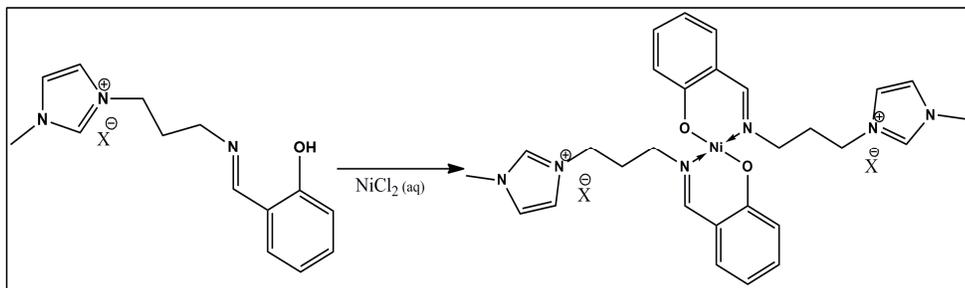


Fig 1.11. Extraction of Ni^{2+} ion from aqueous solution.

The Schiff base quickly decolorizes green aqueous solutions containing Ni^{2+} with which it is placed into contact, the color moving completely into the ionic liquid phase. In Schiff bases azomethine ($-\text{HC}=\text{N}-$) linkage is essential for biological activity, ionic liquid-supported Schiff base ligands were also reported to possess remarkable antibacterial and microbiocidal activities [102].

1.4. Transition Metal Complexes of Schiff Bases

Transition metal complexes of Schiff base are well known to chemist since 1840, when bis(salicyldimino) $\text{Cu}(\text{II})$ was isolated as dark green crystalline solid, by the reaction of cupric acetate with salicylaldehyde and aqueous ammonia [103]. They are one of the most adaptable and thoroughly studied systems in coordination chemistry due to easy synthesis techniques and the synthetic flexibility, enable designs of compounds with different structural properties [104, 105]. The Schiff bases and its transition metal complexes are being studied extremely by researchers owing to their interesting chemical and physical properties and huge applications in different scientific areas [106-108]. These complexes have also important applications in clinical [109] and analytical [110] fields. Again, some of the complexes are applied as model molecules for biological oxygen transporter system [111]. The transition metals are involved in many biological reactions that are very essential to life process

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[112, 113]. The Schiff base metal complexes have useful applications in different field of human interest [114-119]. A large number of paper have been published on relationship between metal ions and their corresponding metal complexes as antitumor and antibacterial agents which is a subject of great interest [120-122].

Schiff base their metal complexes were well established since the mid nineteenth century. The work of two famous scientists Jorgensen and Werner on these metal complexes was gained interest of chemists in the area of coordination chemistry [123]. Pfeiffer and his group [124] mentioned a series of complexes synthesized from Schiff bases of salicylaldehyde and its derivatives. The main privilege of the salicyladiimines ligand is the considerable flexibility of the synthetic procedures facilitating in the synthesis of a wide variety of complexes with a given metal ion whose properties often depend on the ligand structure. Transition metal complexes of Schiff bases are usually formed by adding a metal salts with the Schiff base ligands under suitable experimental conditions. Detailed discussion on synthesis and structural characterization of Schiff base and its metal complexes are available in numerous literatures [125, 126].

In recent years, more attention has been grown on the Schiff base ligands carrying both amino (-NH₂) and hydroxyl (-OH) groups for coordination with suitable metals ions [127]. This is due to the facts that they can be employed for generating substrate chirality, altering the metal centered electronic factor and increasing the solubility and stability of either homogenous or heterogeneous catalysts [128]. Many research articles [129-134] covering the area of synthesis to physico-chemical and biochemically relevant studies on Schiff bases metal complexes revealed that such complexes are very much relevant with the development of modern coordination chemistry. Furthermore, Schiff bases are capable to stabilize various metal ions in different oxidation states and thus control the activity of metals ions in wide variety of effective catalytic transformations [135]. In this regard, the transition metal complexes of Ionic liquid-supported Schiff bases, obtained from different aromatic aldehydes and amine functionalized ionic liquids have become a subject of major interest [100, 101]. The complexes are extensively used as catalyst in numerous numbers of organic transformations as this type of catalyst can easily be reused for five or six steps

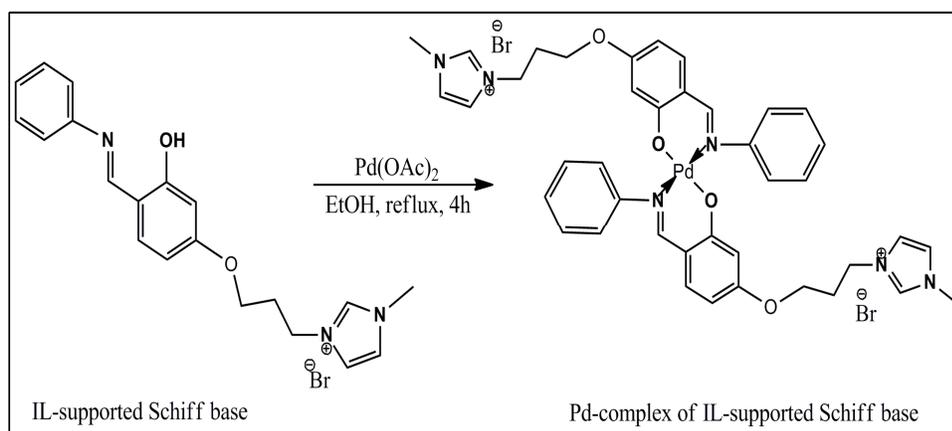


Fig 1.12. Synthesis of Ionic liquid-supported Pd(II) complex.

without much loss of activity and showing an example of sustainable and green methodology. Most of the catalysts are hydrophilic in nature, results in easy separation and recycling of the catalyst from the product. An example is given in Fig 1.12. Thus the ionic liquid-supported Schiff base complexes of transition metal ions have played a key role in many organic transformations to enhance the yield and product selectivity. The suitable path of synthesis and thermal stability of the metal complexes have contributed notably for their possible application in catalysis [99]. The transition metal ions combined such Schiff base ligands show high catalytic activities in reactions of industrial importance and academic interests. It is known that almost all the transition metal complexes of Schiff base ligand exhibits excellent antiviral, anticancer, antibacterial and antimicrobial activity [136, 137]. The potential biological activity can be related to the presence of nitrogen atom with a lone pair of electron in it and that the nitrogen can participate in hydrogen bonding with OH or NH groups present in bio-molecules.

1.5 Literature review

Ionic liquids may be considered as a new and remarkable class of solvents that has a long and interesting history. The first ionic liquids ethyl ammonium nitrate was reported in 1914 by the famous scientist Walden and his coworkers [138] and this IL is a liquid at room temperature. Osteryoung and his group prepared ethylpyridinium bromotrichloroaluminate(III) ([EtPy][AlBrCl₃]) and characterized its chemical and electrochemical properties [139]. In 1983, Hussey first mentioned the term “ionic liquid” to these special molten salts [140]. Wilkes *et al.*, in 1992, reported the

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synthesis of 1-ethyl-3-methylimidazolium tetrafluoroborate ([emim][BF₄]) and 1-ethyl-3-methylimidazolium acetate ([emim][OAc]), and introduced the field of modern research on ionic liquids [141]. Dupont and his coworkers in 1996, developed an important ionic liquid, 1-butyl-3-methyl imidazolium hexafluorophosphate ([bmim][PF₆]), that exhibits hydrophobic nature [142] and strongly simulated chemists to apply them as solvents for different types of chemical reactions especially in organic reactions. In 1998 the formation of ILs by large, asymmetric ions derived from the antifungal drug miconazole was reported by Davis *et al.*, [143]. The report explained the possibilities for formulating salts that remain in the liquid state at low temperature, even while introducing functional groups in the ion structure and promoted the introduction of the concept of task-specific ionic liquid [144]. The same group reported the synthesis of functionalized cations for task-specific ionic liquids, starting from 1-(3-aminopropyl)imidazole and uses of ILs containing functionalized ions [145, 146]. A schematic route for the synthesis of TSILs was given in Fig 1.13.

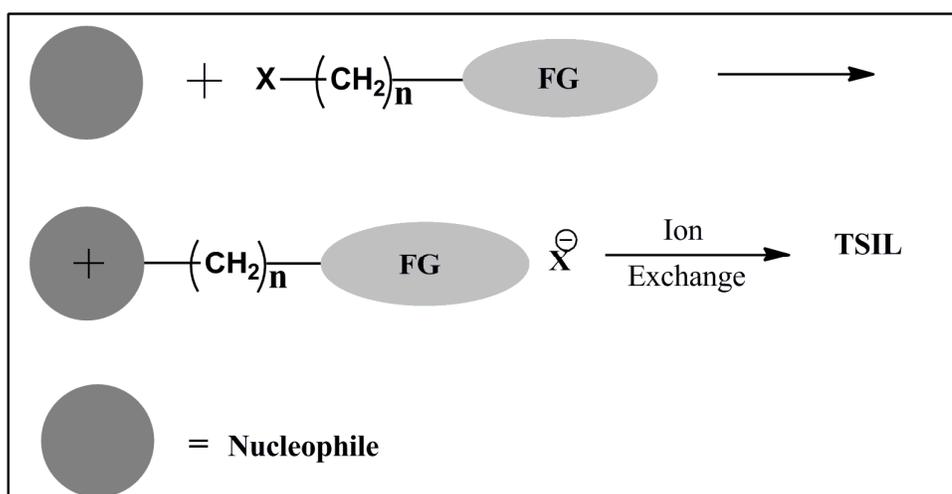


Fig 1.13. Synthesis of TSIL.

Wasserscheid *et al.* [147] introduced a complimentary method for TSIL synthesis using the Michael reaction which is shown in Fig 1.14. Song and his co-worker mentioned the synthesis of amine-functionalized ionic liquid and used it as an efficient nucleophilic scavenger in solution phase combinatorial synthesis [148]. The synthesis of amine-functionalized IL is depicted in Fig 1.15.

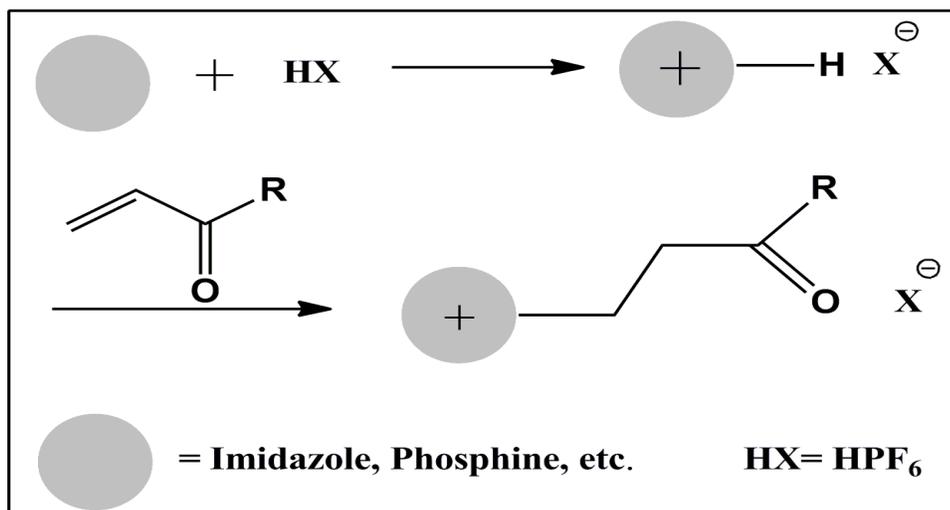


Fig 1.14. Synthesis of TSIL using Michael reaction.

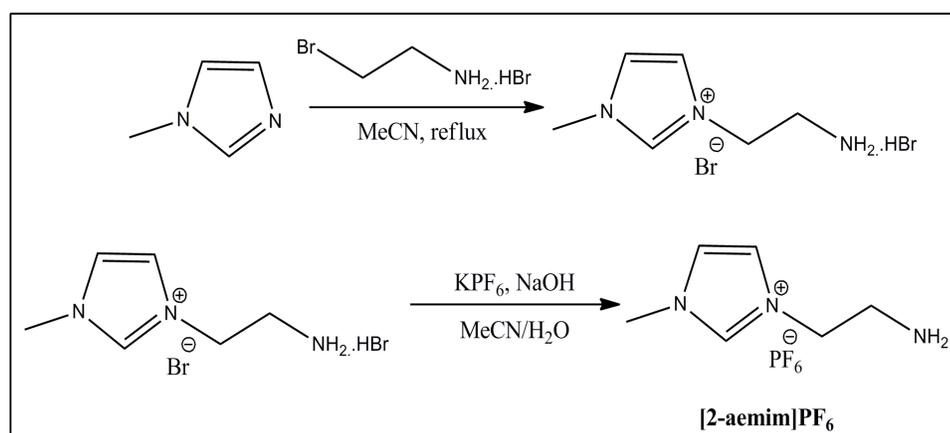


Fig 1.15. Synthesis of amine functionalized ionic liquid.

Gu *et al.*, [149] reported the synthesis of SO₃H-functionalized ILs, which showed a dual role as both a reusable catalyst and a solvent for oligomerization of various olefins. Song *et al.*, [150] investigated on the synthesis of functionalised ionic liquids and their applications as recoverable catalysts for organic reactions and metal scavenger. The same group [151] also reported the synthesis and use of IL grafted Mn(III) Schiff base complex as a highly efficient and recyclable catalyst for the epoxidation of chalcones. Singer *et al.*, [152] reported the synthesis and X-ray crystal structure of a metal chelate prepared from an imidazolium based TSIL with an

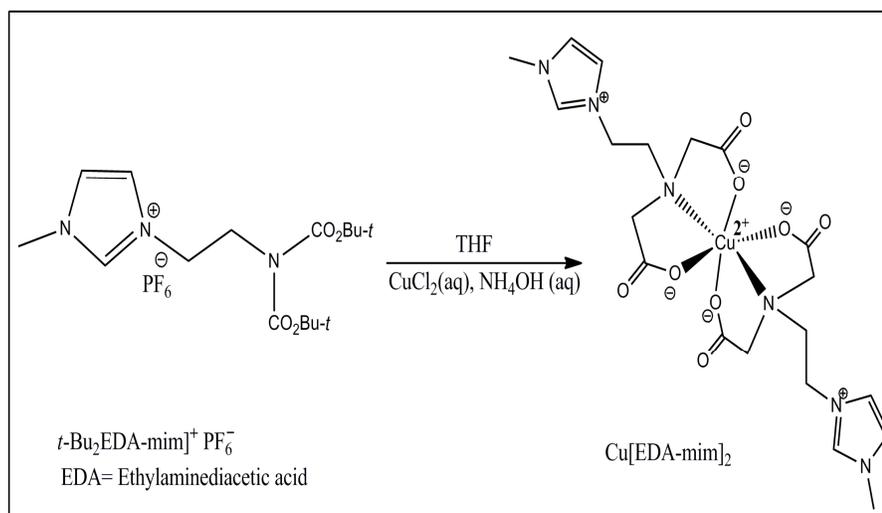


Fig 1.16. Synthesis of Cu[EDA-mim]_2 (Adapted from Ref. No. 152).

ethylaminediacetic acid as the chelating moiety. The ligand reported by them formed 1:2 (M:L) complex with Cu^{2+} ion and the reaction is illustrated in Fig 1.16. Ranu *et al* [153] published several research papers related to the use of ionic liquids as catalyst as well as a reaction medium for useful transformations. Nicasio and Perez group [154] showed the synthesis of IL based Cu^+ complex and its use as catalyst for the transfer of $:\text{CHCO}_2\text{Et}$ unit from ethyldiazo acetate to several saturated and unsaturated substrates with high yields under the biphasic condition with $[\text{bmim}]\text{PF}_6$ and hexane as the reaction medium. D.C. Forbes *et al* [155] reported the formation and application of an imidazolium dirhodium(II) carboxylate metal complex as an active catalyst in the intermolecular cyclopropanation reaction of styrene using ethyl diazoacetate. The pictorial representation is given in Fig 1.17.

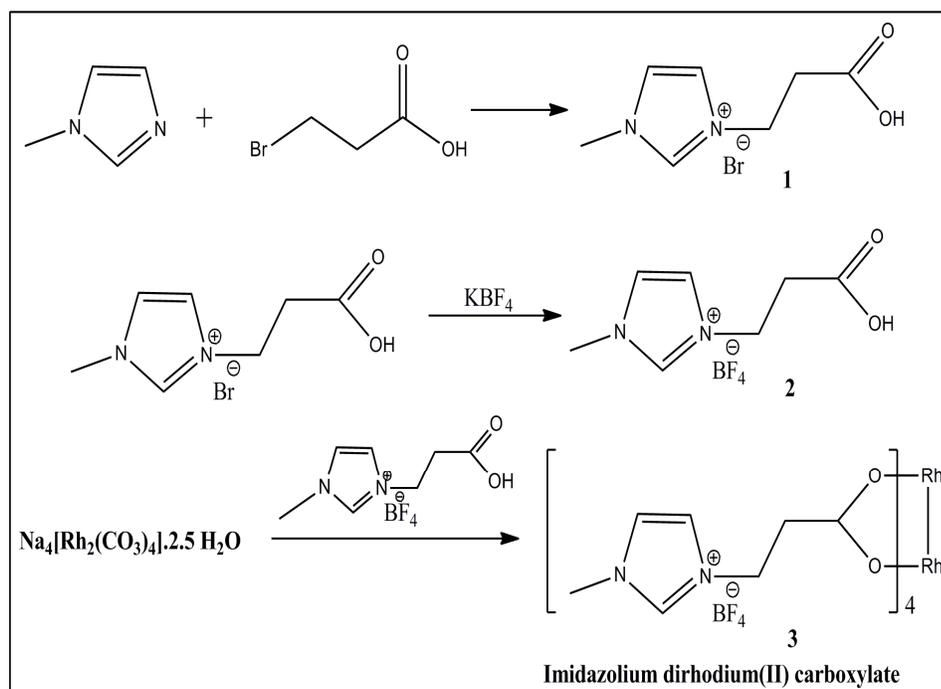


Fig 1.17. Synthesis of imidazolium dirhodium(II) carboxylate. Adapted from Ref. No. 155.

The synthesis of some IL-supported Schiff bases by condensation of some aromatic aldehydes with the amine functionalized ionic liquids without solvent was reported by Li *et al* [156]. The recovery often possess great difficulties and immobilization seems to be a good strategy but the nature of the insoluble supports may suffer from limited activity and accessibility to substrates. Zhao and Peng *et al.*, [157, 158] revealed that IL bonded to chiral salen Mn(II) complex can enhance catalytic efficiency and recovery of the *in situ* formed complex which often showed great difficulties. Yin and his co-workers [159] synthesized chiral oxovanadium(IV) Schiff base complex functionalized by ionic liquid for enantioselective oxidation of methyl aryl sulphides. The synthesized complex was detected as an efficient catalyst and could be isolated conveniently by simple precipitation with addition of hexane and was recycled several times without loss of activity and enantioselectivity. The synthesis of the complex was shown in Fig 1.18.

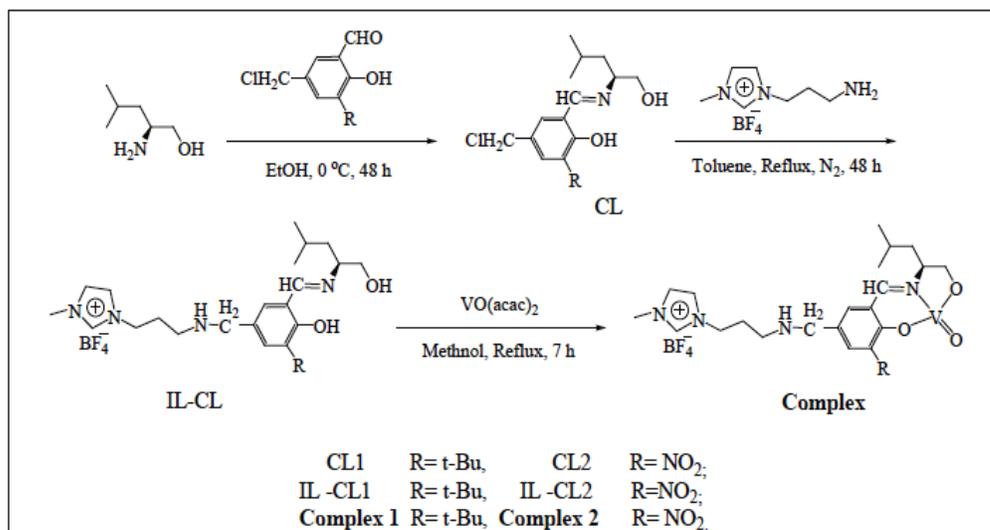


Fig 1.19 Synthesis of the chiral oxovanadium(IV) complex. Adapted from Ref. No. 159.

Shi *et al* [160] synthesized the hydrophobic amino-functionalized ionic liquid and reported its extraction behavior for Cu²⁺ ion as a model cation. The IL, owing to the presence of an amino group, is capable of chelating Cu²⁺ ion and was successfully applied as standard reference material to the analysis of Cu²⁺ ion in environmental water. Kumar and his group [161, 162] reported the synthesis, structural, characterization and microbiocidal activities of ionic liquid tagged Schiff bases. They also used ionic liquid-supported aldehydes as a scavenger to remove primary amines in the synthesis of secondary amines in the solution phase. The synthesis of novel imidazolium ionic liquid-supported Schiff is shown in Fig 1.19.

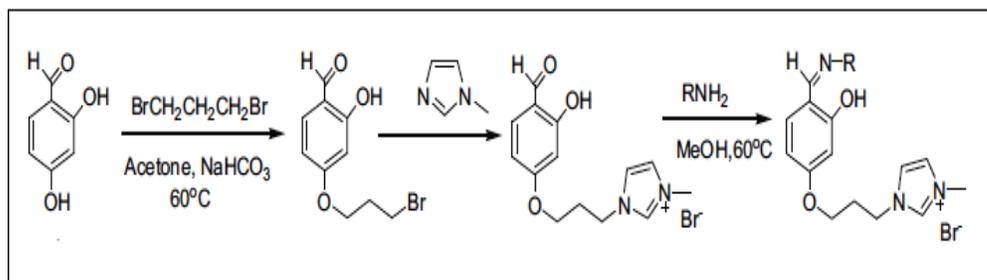


Fig 1.19. Synthesis of IL-supported Schiff base. Adapted from Ref. No. 161.

The same group recently synthesized air stable, water soluble Pd(II) complex of an ionic liquid tagged Schiff base. The complex was used as an efficient catalyst for Suzuki-Heck cross coupling reaction in water medium [163].

1.6. Object and Application of the Research work

Chemistry of functionalized ionic liquids can be regarded as young chemistry, which has drawn chemist's attention not only in organic transformations but also in catalysis especially immobilizing phase for biphasic catalysis, biocatalysis, biotransformation [164-165], pharmaceuticals and extending its wave to every laboratory including academia and industry. Recently, metal-containing functionalized ionic liquids have been found to be more promising salts as they can merge the features of ionic liquids with the catalytic properties of the incorporated transition metal ions [166-167]. In the field of catalysis, there is always a requirement for the invention of an efficient, vigorous and cost effective catalyst that can overcome the drawbacks of the existing catalysts [168-169]. Moreover, environmental awareness and economic consideration compel chemists to develop such a catalytic system that can be revived and reused, especially when harmful metal ions are involved [170-171]. The biological properties of the ionic liquids depend on both their cations and anions [172]. Generally, ILs with long alkyl substituent display significant antibacterial, antimicrobial activity and weak mutagenic properties towards plants although they show less toxicity against animals [172].

In recent years considerable attention has been focused on the modification of Schiff base ligands as their transition metal complexes have wide application in the area of synthesis, catalysis, pharmaceutical and biological activities [173, 136]. However, the synthesis of transition metal complexes from ionic liquid-supported Schiff base ligands and their biological applications in broad range remain unexplored. This research work focuses on: i) the synthesis and physico-chemical characterization of ionic liquid-supported Schiff bases and their transition metal complexes and ii) Exploration of the antibacterial activities of the synthesized compounds against some naturally available gram positive and gram negative bacteria.

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