Catalyzing Strecker Reaction by a Layered Double Hydroxide

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Abstract: Layered double hydroxides (LDHs), have attracted attentions because of their layered structure and high anion-exchange capacity. Positively charged brucite-like layers with interlayer spaces containing anions and water molecules form LDHs structure. Overall structure of LDHs makes it suitable as a heterogeneous catalyst for organic reactions Strecker reaction is an important process in α-aminonitriles synthesis. α-Aminonitriles play key roles in pharmaceutical industry, especially in preparation of α-amino acid and the various nitrogen and sulfur containing heterocycles. Mentioned reaction can be mediated by homogenous catalysts with high yields. Although homogenous catalysts are highly efficient, they are expensive, toxic and need tedious work up. So heterogeneous catalysts such as molecular sieves, natural polymers, nano-sized materials and metal organic frameworks are some promising alternatives for this three-component reaction. In this study, we used LDH as a heterogeneous catalyst for Strecker reaction, which resulted in high yields and short reaction time.

Keywords: layered double hydroxide; Strecker reaction; transition metals; heterogeneous catalysts

Background: Layered double hydroxides (LDHs), with their layered structure and high anion-exchange capacity [1] have positively charged brucite-like layers with interlayer spaces containing anions and water molecules form LDHs structure. The general formula of LDHs is $[M_{1\_x}^{2+}M_x^{3+}(OH)_2]A_{x/n}^{n-1}.yH_2O$. Overall structure of LDHs makes them suitable as a heterogeneous catalyst for organic reactions [2-3].

Strecker reaction is an important process in α-aminonitriles synthesis. α-Aminonitriles play key roles in pharmaceutical industry, especially in preparation of α-amino acid and the various nitrogen and sulfur containing heterocycles [4]. Mentioned reaction can be mediated by homogenous catalysts with high yields. Although homogenous catalysts are highly efficient, they are expensive, toxic and need tedious work up. So heterogeneous catalysts such as molecular sieves, natural polymers, nano-sized materials and metal organic frameworks are some promising alternatives for this three-component reaction [5].

In this study, we used an LDHs as heterogeneous catalysts for Strecker reaction, which resulted in high yields and short reaction time.

Methods: LDH consisting of Mg and Al ions was synthesized by mechanical methods. Three different aldehydes and aniline with LDH was stirred at room temperature for 2 hours. When imine was formed, TMSCN (Trimethylsilyl cyanide) was added to reaction mixture and the product was crystallized.

Result: Strecker reaction, shown in Fig.1, was catalyzed with LHDs and high yields were achieved in short time.

Fig. 1 Strecker Reaction catalyzed with LDHs

The starting materials, yield percentages and melting points of the products in comparison with similar products in the literature are all given in Table 1. It can be seen that the good yields and compatible melting points of the products was acceptable.

Table 2 Starting aldehydes and amine. Yield and melting points of three examined entries

Entry	Aldehyde	Amine	Yield%	Mp	Mp^{Ref}
1	PhCHO	Aniline	98	80–82	80–82
2	2-(Cl)C_6H_4CHO	Aniline	96	65-67	63–66
3	4-(Me)C_6H_4CHO	Aniline	93	79-81	77–78

Conclusion: LDH catalyst showed satisfied efficiency in Strecker reaction. In this method, high efficiency yield is achievable in short time minutes.

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