

SYNLETT Spotlight 192

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

Al–NiCl₂·6H₂O: A Mild and Efficient System for Selective Reduction of Functional Groups in Organic Synthesis

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Introduction

The most common broad-spectrum reducing agents are metal hydrides like LiAlH₄, NaBH₄, DIBAL-H, and 9-BBN. Apart from this, some hydrogenation catalysts have been investigated in order to find conditions under which a given group will be reduced chemoselectively.¹ Metal-metal-salt binary systems such as Al–NiCl₂·6H₂O·THF,² Al–SbCl₃ or Zn–SbCl₃,³ Fe–NiCl₂·6H₂O·THF,⁴ or Sm–

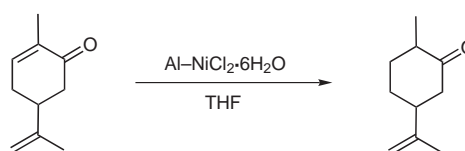
NiCl₂·6H₂O·THF⁵ have long been used as reducing agents for many functional groups.

Reagents based on aluminum find wide application in organic synthesis.⁶ The Al–NiCl₂·6H₂O system is a highlight in current organic chemistry due to its selectivity, mild reaction conditions, easy handling, low cost, and convenient isolation process.

Abstracts

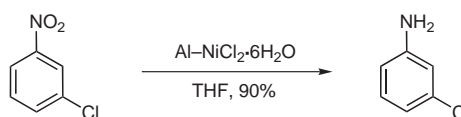
(A) Chemoselective reduction of α -enones:

α,β -Unsaturated carbonyl compounds give saturated ketones upon treatment with Al–NiCl₂·6H₂O. Aromatic aldehydes and ketones are smoothly reduced to the corresponding alcohols. Isolated double bonds, esters, aliphatic aldehydes, and ketones remain unaffected by this reagent.⁷



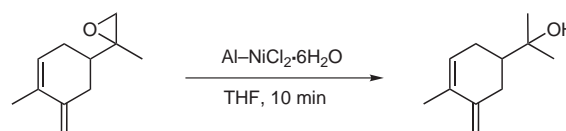
(B) Reduction of nitroarenes to amines:

Sarmah et al. showed that aromatic nitro compounds are reduced to the corresponding amines efficiently under neutral and mild conditions. Short reaction times and a simple work-up procedure make this a versatile reagent.⁸



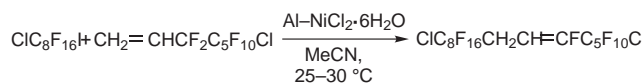
(C) Conversion of oxiranes into alcohols:

Ring opening of the oxiranes takes place from the less hindered side of the epoxides, thereby giving the highest-substituted alcohols. An exception is the case of styrene oxide, where 1-phenylethanol is the major product. α,β -Epoxy ketones remain unaffected under these reaction conditions.²



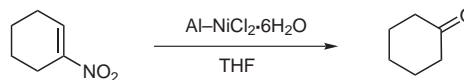
(D) Addition to electron-deficient alkenes:

The Al–NiCl₂·6H₂O redox couple promotes the addition of per(poly)fluoroalkyl iodides to per(poly)fluoroalkyl-substituted ethenes, giving the corresponding addition–elimination products in moderate yields.⁹

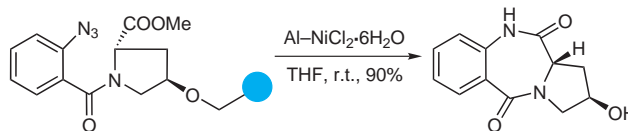


(E) Conversion of nitroolefins into carbonyl compounds:

Saturated ketones can be obtained from nitroolefins in mild reaction conditions with Al–NiCl₂·6H₂O.¹⁰

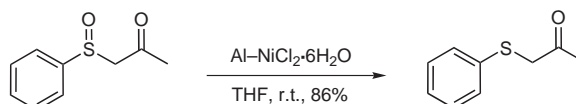


(F) Synthesis towards pyrrolo[2,1-c][1,4]benzodiazepines (PBD): Employing Al–NiCl₂·6H₂O, many heterocyclic compounds like PBDs and dilactams can be synthesized via solid-phase reductive cyclization of nitro and azido compounds.¹¹



(G) Facile reduction of sulfoxides to sulfides:

Sulfoxides can be reduced to the corresponding sulfides within short periods of time in high yields. Interestingly, ketones are not reduced under these reaction conditions.¹²



References

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