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Catalytic conversion of linear low density polyethylene into carbon nanomaterials under the combined catalysis of Ni_2O_3 and poly(vinyl chloride)

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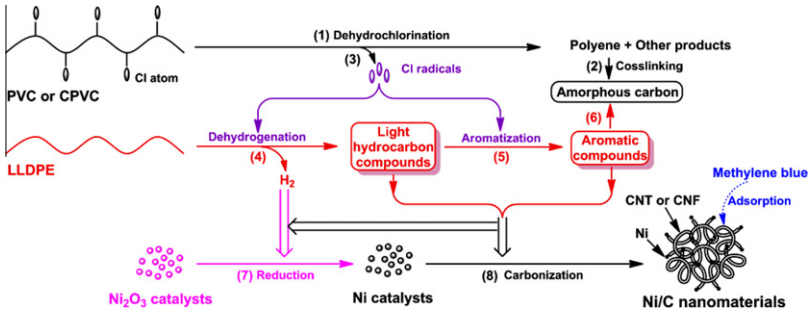
HIGHLIGHTS

- Catalytic conversion of linear low density polyethylene (LLDPE) into magnetic Ni/C nanomaterials.
- The yield and morphology of Ni/C were modulated by PVC content.
- Chlorine radicals influenced degraded products of LLDPE for growth of Ni/C.
- Ni/C acted as efficient adsorbents for methylene blue.

GRAPHICAL ABSTRACT



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ABSTRACT

A one-pot method was used to prepare magnetic Ni/carbon (Ni/C) nanomaterials by catalytic carbonization of linear low density polyethylene (LLDPE) under the combined catalysis of Ni_2O_3 and polyvinyl chloride (PVC) resin. The yield of Ni/C nanomaterials was determined by the pyrolysis temperature, the type and the content of PVC resin. The yield of magnetic Ni/C nanomaterials first increased and then decreased with increasing PVC content. The obtained carbon nanomaterials mainly consisted of long carbon nanotubes (CNTs) at lower PVC content but short carbon nanofibers and amorphous carbon at higher PVC content. This is attributed to chlorine radicals from the decomposition of PVC resin promoting the dehydrogenation and aromatization of LLDPE macroradical fragments. The obtained magnetic Ni/C nanomaterials were used as adsorbents for the removal of methylene blue (MB) from water and showed an adsorption capacity as high as 165.5–175.2 mg/g, indicating the resultant magnetic Ni/C nanomaterials had potential application in wastewater treatment.

1. Introduction

Due to the lack of proper treatment for the plastic after usage, the waste plastics have caused environmental pollution. The development of technically and economically feasible chemical recycling processes for the waste plastics has been a hot topic. Polyolefins are the main components of waste plastics. The content of carbon in polyolefins is about 85.7 wt.% [1], thus polyolefins are affluent carbon resources for the production of carbon materials. Many studies [2–10] have demonstrated that virgin or waste polyolefins including polyethylene (PE) and polypropylene (PP) can be transformed into various carbon materials such as carbon nanotubes (CNTs), carbon nanofibers (CNFs) and graphene. In our previous works [7,8], the combined catalysts of halogenated compounds (such as CuCl, $FeCl_3$ and NH_4Cl) and Ni_2O_3 have been proven to be effective for high-yielded conversion of PP into CNTs or CNFs. The halogen radicals from the decomposition of halogenated

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