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CIRCULAR PLASTICS NETWORK FOR TRAINING

ESR4: An innovative catalytic system for the exchange reaction of phosphate esters with N-nucleophiles towards the production of sustainable and recyclable phosphorus flame-retardant additives

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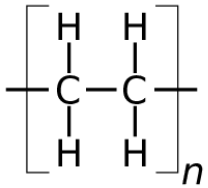
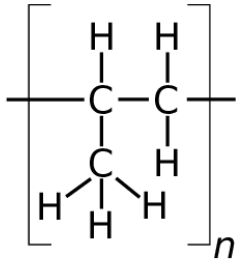
Introduction: Context and Relevance

- Polymeric materials are present in nearly all aspects of modern life

- Hydrocarbon-based polymers display high flammability and large fire load!

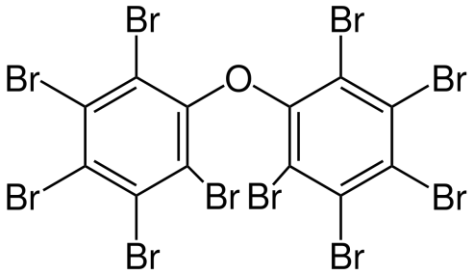


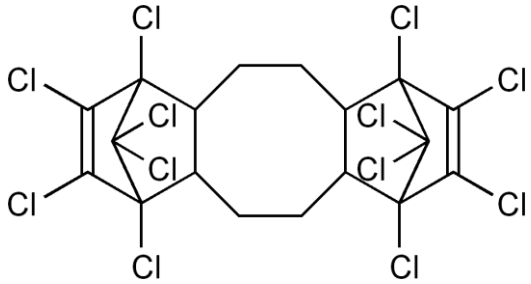


Introduction: Context and Relevance

- Flame retardants play a vital role in reducing the risk and safeguarding against accidental fires

- Halogenated fire retardants were widely used in the past; however, their hazardous nature prompted increased research towards the development of halogen-free flame retardants



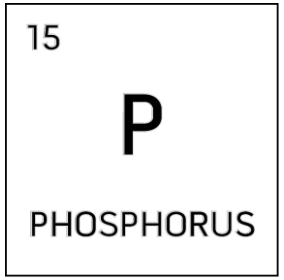


- Phosphorus-based flame retardants have now become a prominent alternative!

S. Shaw,Rev.Environ.Health 2010,25,261–306

Introduction: Context and Relevance

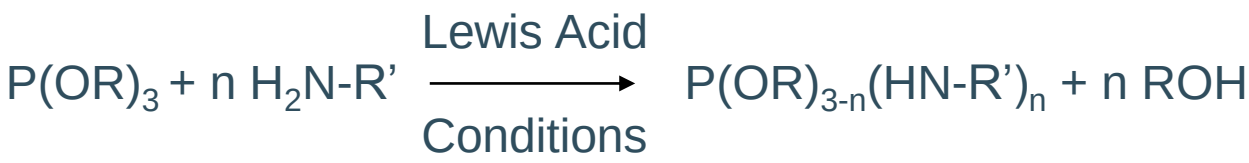
- Phosphorus plays the key role!
  - Chemical versatility
  - Multiple flame-retardancy mechanisms
  - Highly effective at low loadings



- But for the additive to be a good flame retardant, it needs to…
  - Conserve the polymer properties (with price as the most determining factor)
  - Match the polymer processing and pyrolysis characteristics
  - Be environment friendly, recyclable, and sustainable.

Angew.Chem. Int. Ed .2018, 57,10450–10467

Goals



- To develop a sustainable method for preparing new and recyclable phosphorus based flame-retardant additives
  - A catalytic system using solid Lewis acid catalysts is envisioned to prepare such compounds
  - Phosphoesters exchange reactions using N-nucleophiles will be studied
  - Non-hazardous and environmental friendly process

Challenges

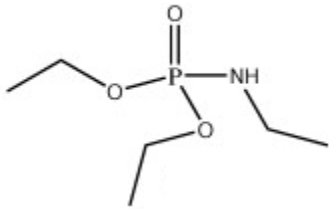
- The nucleophilic addition of nitrogen to phosphoesters is not obvious
- There is not that much information.
- The final product must meet the “Good FR” criteria

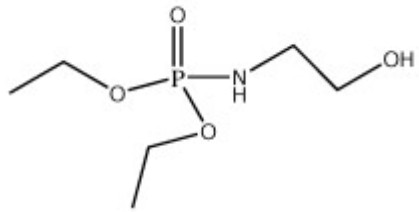
Expected outcome

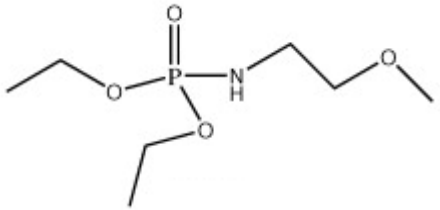
- We expect to develop a reliable method for producing FR additives that is not only efficient, but also safe and envioramental friendly.

- This method will use a solid catalyst that will be easy to recover (best case scenario the poisoning of the catalyst will be minimum)

- Various kinds of phosphoramides with good FR properties will result from this method







Thank you!

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