

Research in Mike Chung's Group

Ph.D and Postdoctor
(1979-1982-1984)

Exxon (Corporate Research)
(1984-1989)

Penn State U
(1989-Now)

Conducting Polymers

Butyl rubber (EXXPRO)

Functional polyolefins

Polyisobutylene (PIB)

Functional fluoropolymers

Polyolefin Catalysis

Polymer/inorganic
nanocomposites

Polymer film capacitors

PEM at High T Low Humidity

B/C for hydrogen Storage

Control radical polymerization based
on borane/oxygen initiator

The logo for CSPS (Central Science and Polymer Science) features the letters C, S, P, and S in a bold, white, sans-serif font. The letters are arranged horizontally and are partially enclosed by a blue circular graphic element that forms a partial ring around them. The background of the slide is a dark blue gradient.

Functionalization of Polyolefins (side chains); The combination of metallocene and reactive comonomers

α -Olefin + "Reactive" Comonomer



Metallocene Catalyst

**Polyolefin Copolymer
Containing Reactive Groups**

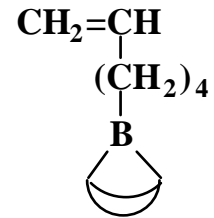
Functionalization
Reaction

**Functional
Polyolefin**

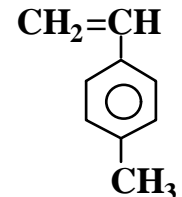
Graft-from
Reaction

**Polyolefin
Graft Copolymers**

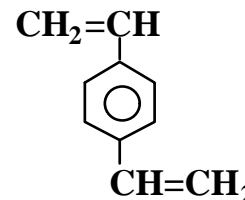
Reactive Comonomers



US Patent 5,286,800
US Patent 5,401,805
US Patent 5,837,365
US Patent 5,976,434



US Patent 5,543,484
US Patent 5,866,659
US Patent 6,015,862



US Patent 6,096,849
US Patent 6,265,493
US Patent 6, 414,102

“Functionalization of Polyolefin” Academic Press, 2002

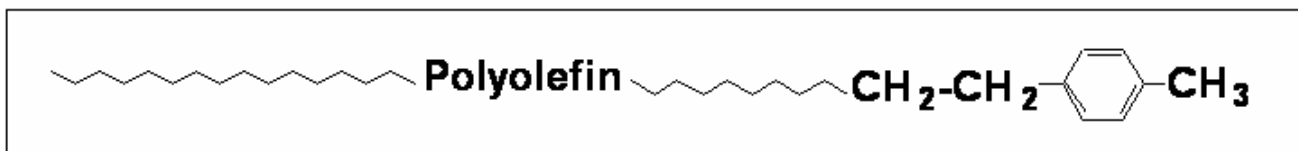
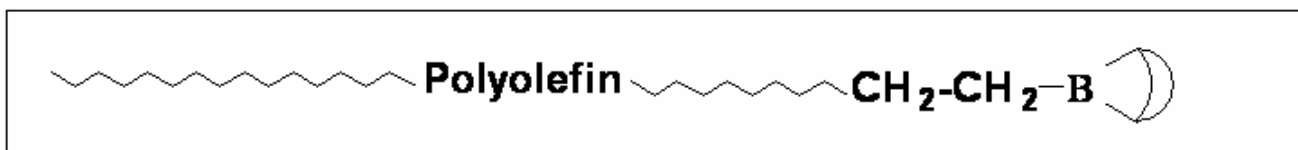


Functionalization of Polyolefins (chain End);

The combination of metallocene and reactive chain transfer agents

α -Olefin + Reactive Chain Transfer Agent

↓ metallocene catalyst



Functionalization

Chain Extension

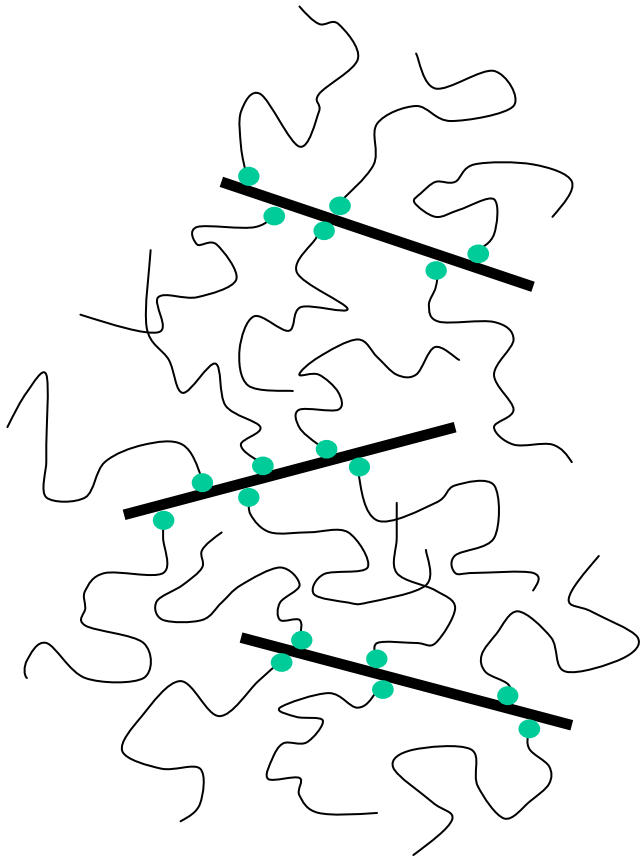
**Polyolefin with A
Terminal Functional Group**

**Polyolefin Diblock
Copolymers**

U. S. patent 6,248,837; U. S. patent 6,479,600; U. S. patent 6,515,088

Exfoliated Polymer/Clay Nanocomposite

**(Using Chain End Functionalized Polyolefins
or Fluoropolymers as Polymer Surfactants)**



At Clay/Polymer Interface

(a) Ion Exchange with $\text{Si-O}^- \text{M}^+$

- ammonium or imidazolium

(b) Chemical Bonding with Si-OH

- Si-OR or OH group

Z. M. Wang, H. Nakajima, E. Manias, and T. C. Chung

Macromolecules 36, 8919, 2003.

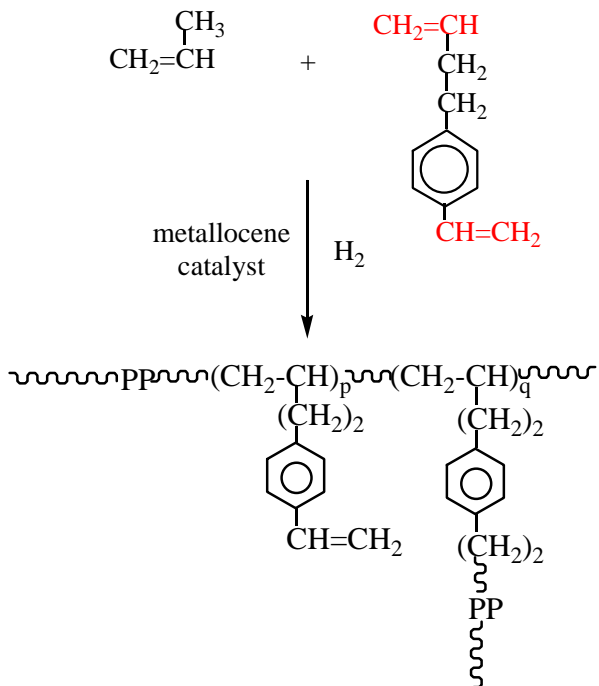
International Patent Number WO2005044904

European Patent Application No. 04816777.9

US Patent Application 10/891,358 (allowed)

Mitsubishi is studying commercialization

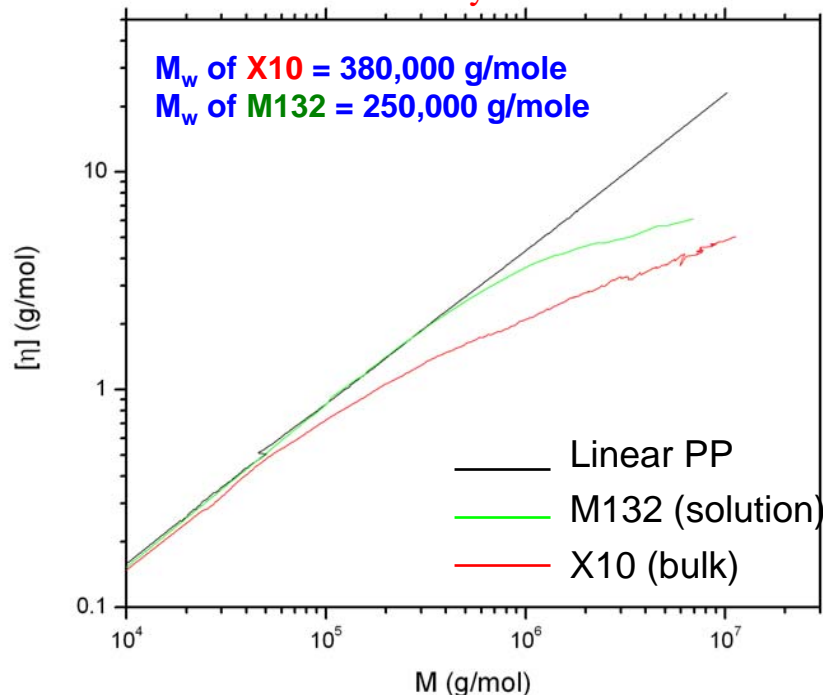
Long Chain Branched PP (LCBPP) Polymers



1 liter batch reactor
 100-200 g
 polymer/batch

Mark-Houwink Overlay

measured by Dow



Macromolecules, 38, 5349, 2005

International Publication Number WO 2006/007512 A1

European Patent Application 05763536.9

US Patent Application 11/170,698 (2005)

Mitsubishi is studying commercialization

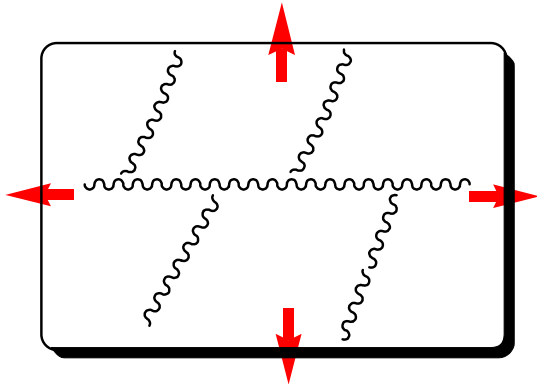


The Center for the Study of Polymeric Systems

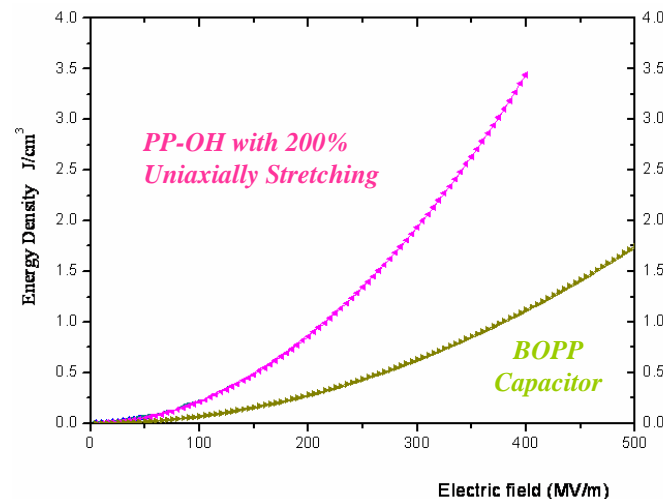
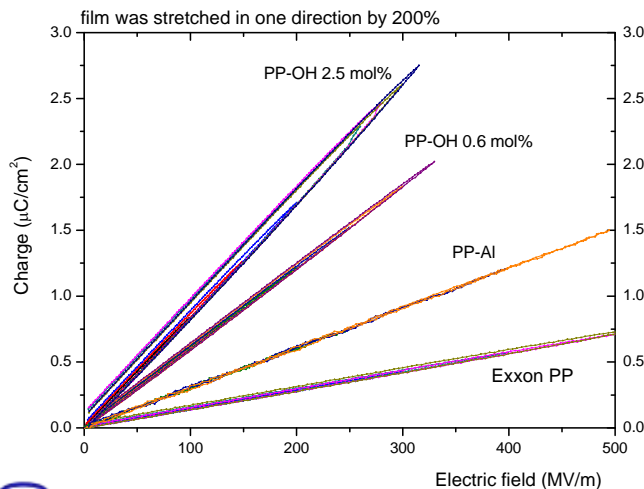
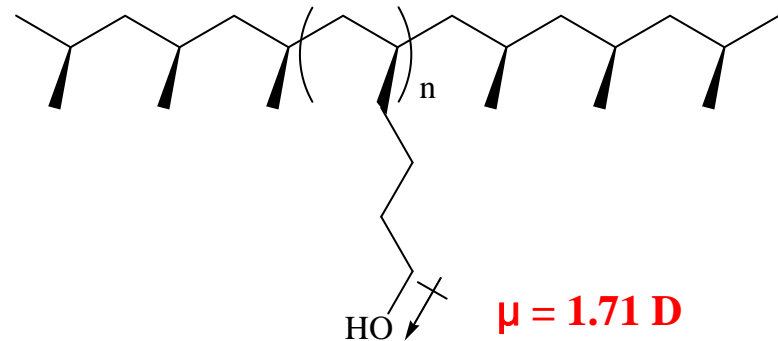
PENNSSTATE CENTERS OF EXCELLENCE

PP Capacitors; Using LCBPP and Functional Polymers

Bi-axial orientation of LCBPP to form thin film with high crystallinity

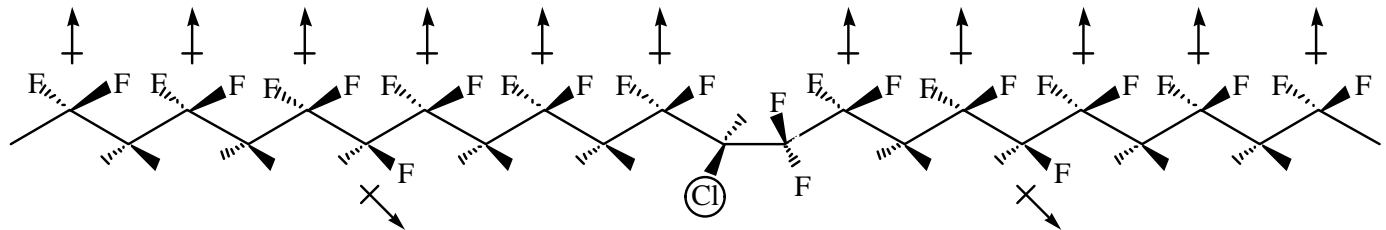


Functional PP Containing Polar Groups (PP-OH)

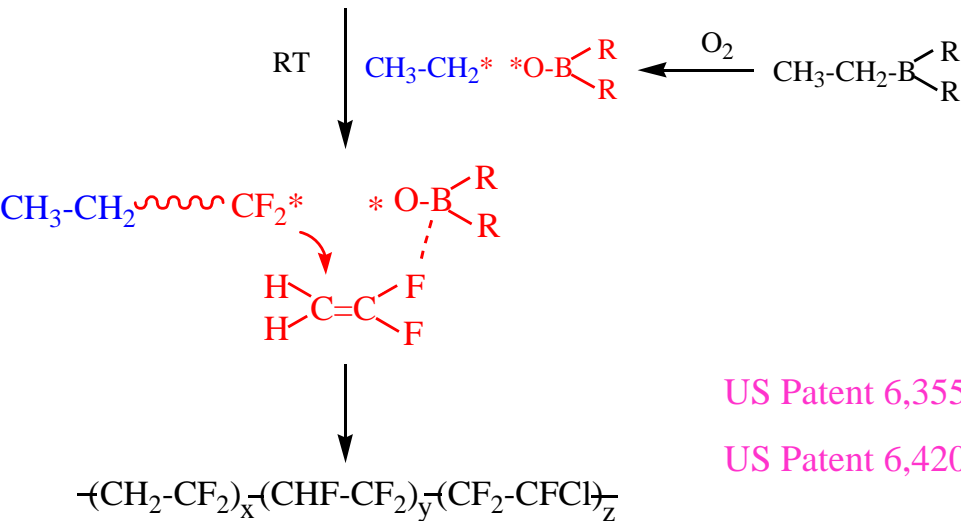
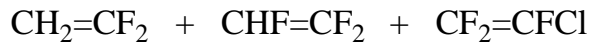


Ferroelectric Fluoropolymer; with high dielectric constant and low polarization hysteresis

VDF/TrFE/CTFE
terpolymer



Control Radical Polymerization

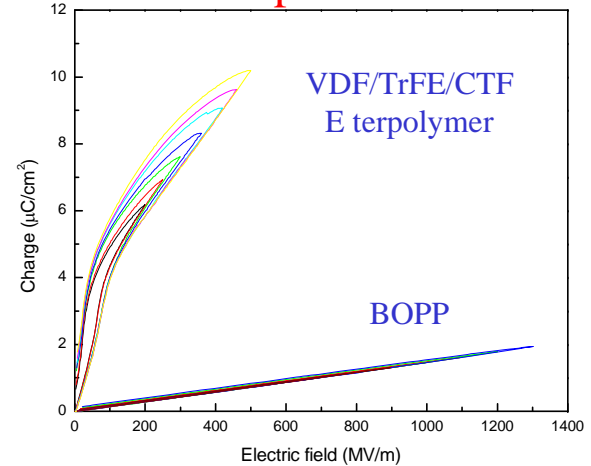


US Patent 6,355,749

US Patent 6,420,502

Kink

Capacitors



Ferroelectrics Letters 28, 135, 2001.

Macromolecules 35, 7678, 2002

Chem. Mater. 14, 2590, 2002

J. Appl. Phys., Appl. Phys. Lett. 83, 1190, 2003.

J. Appl. Phys., Appl. Phys. Lett. 84, 1737, 2004

Macromolecules 39, 5187, 2006.

Macromolecules 39, 4268, 2006.

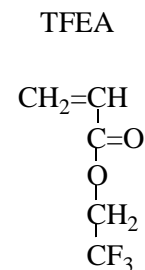
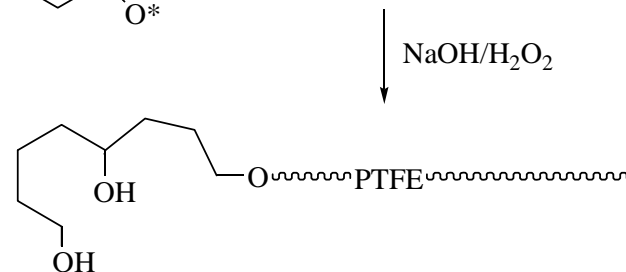
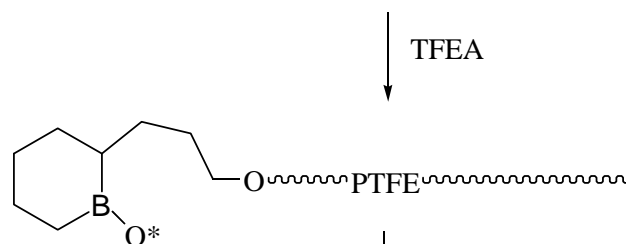
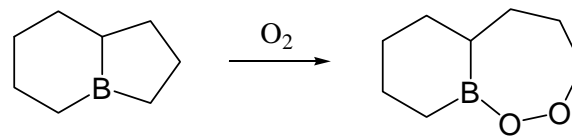
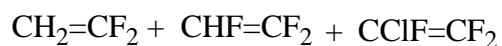
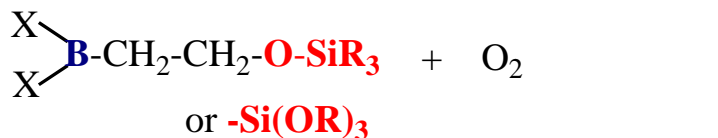
Macromolecules 40, 783-785, 2007



The Center for the Study of Polymeric Systems

PENNSTATE CENTERS OF EXCELLENCE

Functional Fluoropolymers (Chain End); Using Functional Borane Initiator



U. S. Patent Application 0182208 A1. (allowed)
International Patent Number WO 2005085298 A1
European Patent Application No 04711840.1

Macromolecules 37, 6260, 2004
U. S. Patent 6,911,509
International Patent Number WO 2005085297 A1
European Patent Application No 04711824.5



Functional PP: Mitsubishi Chemical Group

Functional fluoropolymers: Daikin USA

Capacitors: ONR

PEM: DOE

H₂ storage: DOE



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CENTERS OF EXCELLENCE