

Nanomer[®] Nanoclay as Flame Retardation Additives

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Environmentally Friendly Flame Retardants, July 19-20, 2007



Outline

- Nanoclay Chemistry
- Nanoclay in Flame Retardation
- Combination of Nanoclays and standard FRs
- Nanoclay Processing Advantage



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Company Information



www.amcol.com (NYSE: ACO)

AMCOL International Corp., through its operating subsidiaries, is a leading international producer and marketer of value-added, specialty minerals and related products. The Company's products serve 12 major markets, including—metalcasting, detergents, pet products, building materials and personal care. AMCOL operates a transportation segment that acts as a servicing operation for other business segments and outside customers.

Headquartered in Arlington Heights, Ill., AMCOL operates 68 facilities in Asia, Australia, Europe and North America. The Company employs 1,750+ employees in more than 26 countries. The Company, established in 1927,

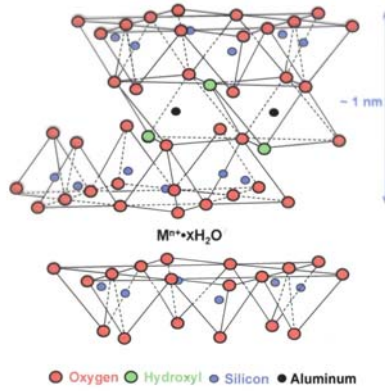
 **Nanocor** nanoclay based plastic additives



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Nanoclay



Natural materials
FDA: GRAS

Long history of use

Existing in nano state in water

Good chemical modification responses



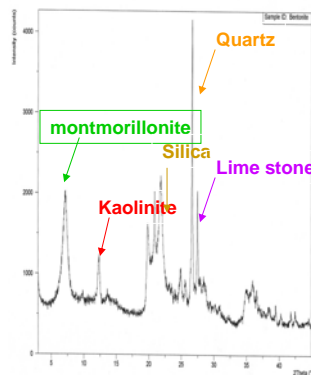
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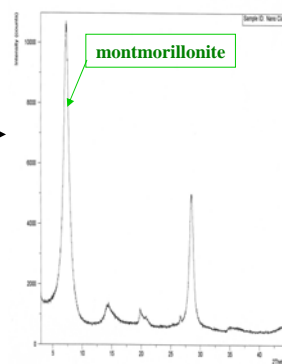
Nanoclay

Ancient clay-volcanic ash

Nanoclay-plastic additives



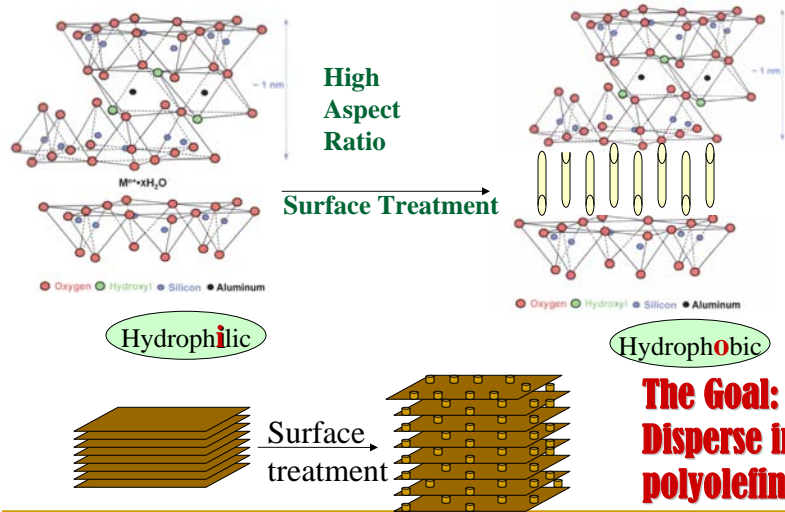
US Patents:
6,050,509
6,235,533



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Nanomer[®] Formation

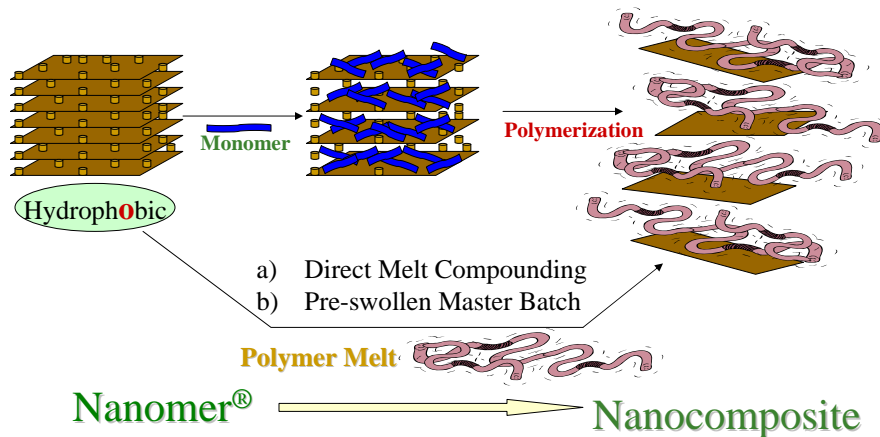


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Making Nanocomposites

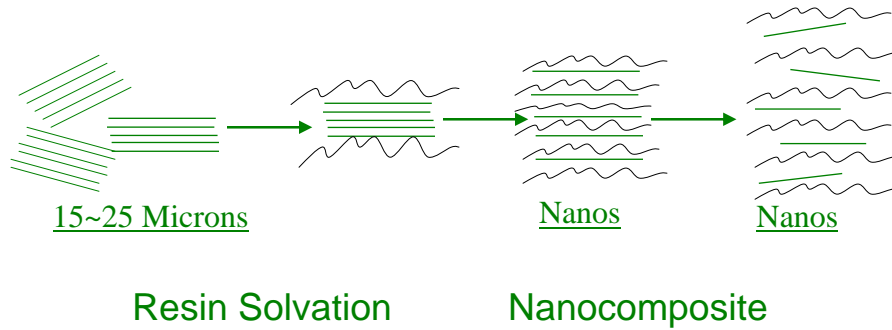
The Goal: Separate into Individual Layer!



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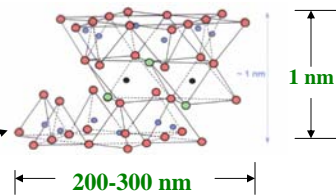
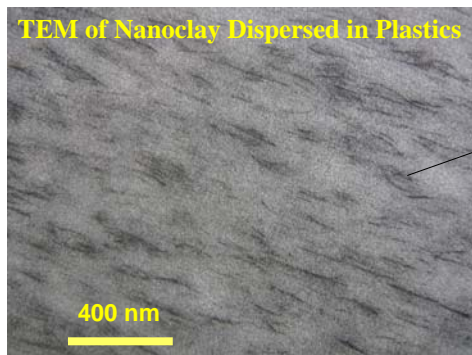
NANOCOMPOSITE



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Nanocomposite



Nanoclay platelets are one-ten thousandth the diameter of a human hair!!



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Nanocomposite

- **Barrier property enhancement**
- **Mechanical properties improvement**
 - **Increase stiffness without loss of flexibility**
 - **Increased dimensional stability**
- **Chemical and thermal stability**
- **Flame retardation in combination with FR agents**
- **Processing Characteristics**



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Burning of Nanocomposites



Nanoclay in EVA

Nanocomposites

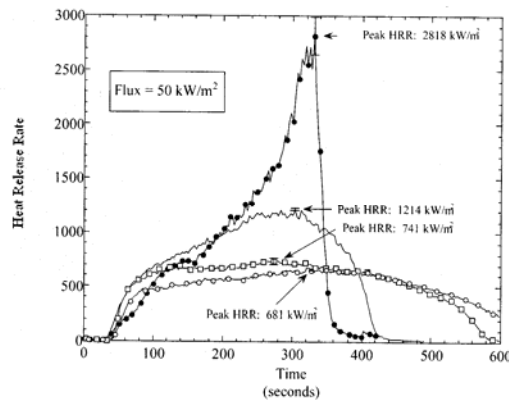
- **Slow down burning**
- **Promote char formation**
- **Anti-dripping effect**
- **Can NOT put out fire**



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Reduce PHHR

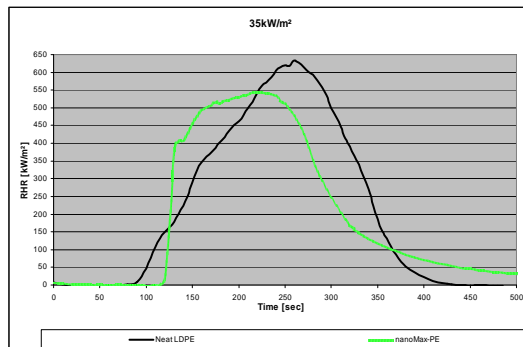


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Nanoclay as FR Additives

LDPE-Nanoclay Systems



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Combination of Nanoclay with Regular FRs

- Br systems
- MDH, ATH systems
- Intumescent systems



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Nanoclay as FR Additives

PP-BR-ATO-Nanoclay Systems

Components	Formula 1	Formula 2	Formula 3	Formula 4
DECA (wt%)	25	25	25	22
ATO (wt%)	6	6	6	5
Nanomer (wt%)	0	6	4	6
UL-94 rating (1/8 in)	V1	V-0	V-0	V-0
Flex Strength (MPa)	46	51	52	53
Flex Modulus (MPa)	1810	2570	2490	2740



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Nanoclay as FR Additives

PP-BR-ATO-Nanoclay Systems

- Brominated compounds reduction
- Balanced mechanical properties
- Reduced specific gravity
- Reduced blooming



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Nanoclay as FR Additives

EVA-MDH-Nanoclay Systems

Components	Formula 1	Formula 2	Formula 3	Formula 4
EVA (wt%)	40	45	42	47
Mg(OH) ₂ (wt%)	60	55	55	50
Nanomer I.44P (wt%)	0	0	3	3
Resin/Filler Ratio	0.67	0.82	0.72	0.90
UL94 rating (1/8 in)	V-0	Fail	V-0	V-0



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Nanoclay as FR Additives

PP-MDH-Nanoclay Systems

Components	Formula 1	Formula 2	Formula 3
Co-PP (wt%)	35	40	40
Mg(OH) ₂ (wt%)	65	60	55
Resin/Filler Ratio	0.54	0.67	0.74
nanoMax-PP-nH (wt%)	0	0	5
UL94 rating (1/8 in)	V-0	Fail	V-0



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Nanoclay as FR Additives

ATH/MDH-Nanoclay Systems

- ATH/MDH reduction
- Increase resin/filler ratio, enhance processability
- Increase processing speed with better part surface
- Reduce specific gravity



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Nanoclay as FR Additives

PP-APP-Nanoclay Systems

Components	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5
AP752 (wt%)	24	26	28	24	24
PP (wt%)	76	74	72	75	73
Nanomer (wt%)	0	0	0	1	3
UL-94 rating (1/8 in)	V2	V-1	V-0	V0	V-0
Flex Modulus (MPa)	1970	1940	2000	2200	2400



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Nanoclay as FR Additives

PP-APP-Nanoclay Systems

- Minimum nanoclay loading level
- Reduction of intumescent FR
- Enhance char forming and char strength
- Increase processability
- Increase mechanical properties



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Commercial Applications:

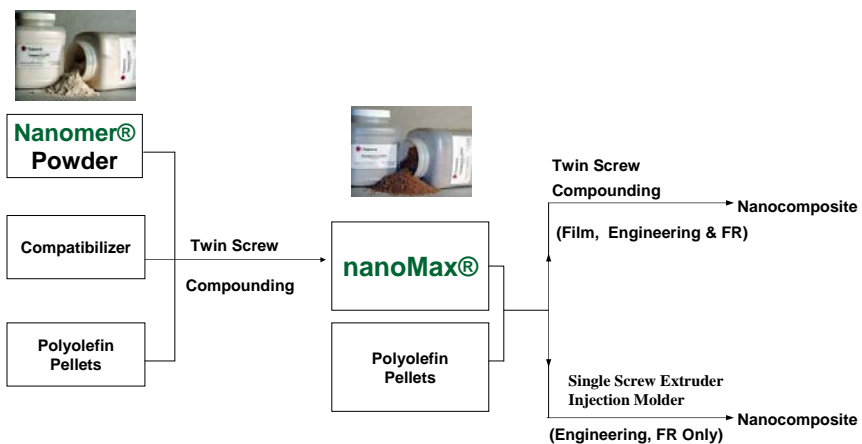
- Wire and Cable
- Injection molded parts
- Industrial and household hoses
- Laminate and decorative coatings



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Nanoclay Masterbatch



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Benefits for Wire and Cable:

- **Enhanced flame protection: Slow down flame spreading due to char forming and non-dripping**
- **New cable jackets design:
Nano-FR jacket and non-filled insulation layer**
- **Possible to reduce ATH and MDH to enhance processability and flexibility of the cables**
- **Enable producers to meet new EU CPD classification**



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Nanocomposite Processing

EVA based:

**It is more difficult to disperse ATH or MDH than
Nanomer**

Nanomer powder or nanoMax masterbatch:

Buss Kneader, internal mixer, twin screw

PE based:

nanoMax is recommended

Buss Kneader, internal mixer, twin screw



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Nanocomposite for Cable Applications



Coaxial cable (1/2") with an LSO0H-nanocomposite based jacket

UL 1666 requirements	EVA/ATH compound	EVA/ATH/Nanoclay Compound
maximal temperature at 12 feet: < 850°F	1930°F	620°F
maximal flame height: < 12 feet	> 12 feet	6 feet



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Nanoclay as FR Additives



Reduce Toxicity :

Reduction of Traditional Br-FR Agents

Increase Materials Yield:

Reduction of S. G.

Increase Efficiency/Productivity:

Reduce scrap

Safer Products

Low burning temp and slow flame spreading



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Summary

- **Nanoclays are effective flame retardation additives to plastics with environmental benefits.**
- **Plastic nanocomposites are commercially produced and used.**
- **Nanocomposite FRs offer easy processability compared to regular FR systems.**



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Thank You