# Chemical Recycling Overview for PP, PS, PU, and EVA

## 1. Polypropylene (PP)

### Chemical Recycling Methods:

Pyrolysis: Heating PP in the absence of oxygen to produce hydrocarbons such as gases, waxes, oils, and liquid fuels.

Hydrogenation: Uses hydrogen to break down PP into hydrocarbons.

Gasification: Converts PP into synthesis gas (syngas), a mix of hydrogen and carbon monoxide.

### Resulting Chemicals:

Olefins (ethylene, propylene): Can be used to make new PP, polyethylene (PE), or other polyolefins.

Waxes and oils: Serve as industrial lubricants, fuels, or synthetic waxes.

Syngas: Used as a precursor for methanol or as a fuel.

Naphtha: Petrochemical feedstock for new plastics and chemicals.

### Possible Products/Materials:

New PP Products: Packaging, automotive components, fibers.

Fuels: Diesel, gasoline.

- Waxes: Coatings, polishes, candles.

- Naphtha-based materials: For chemical and plastic production.

### Companies/Countries in Asia:

- Packaging: Indorama Ventures (Thailand), SABIC (Saudi Arabia, with operations in Southeast Asia).

- Automotive Components: Toyota Boshoku (Japan), Hyundai Mobis (South Korea).

- Fuels: PetroChina (China), Indian Oil Corporation (India).

- Waxes: Sinopec (China), Thai Oil (Thailand).

- Naphtha: Reliance Industries (India), SK Global Chemical (South Korea).

## 2. Polystyrene (PS)

### Chemical Recycling Methods:

- Depolymerization: Breaks PS into its monomer, styrene, via thermal or catalytic methods.

- Pyrolysis: Produces styrene oil, which can be refined.

- Solvolysis: Uses solvents to degrade PS into styrene monomers or other products.

### Resulting Chemicals:

- Styrene Monomer: For new polystyrene or other styrenic polymers like ABS.

- Aromatic Compounds (benzene, toluene): Used as solvents or intermediates.

- Oligomers and light hydrocarbons: For petrochemical processes.

### Possible Products/Materials:

- New PS Products: Food packaging, insulation materials, disposables.

- Styrenic Polymers (e.g., ABS): For appliances, automotive parts, toys.

- Aromatic Chemicals: In solvents, chemical synthesis.

- Feedstocks: For chemical production.

### Companies/Countries in Asia:

- Food Packaging and Disposable Items: Formosa Plastics Group (Taiwan), Supreme Petrochem (India).

- Styrenic Polymers (ABS): LG Chem (South Korea), Toray Industries (Japan).

- Aromatic Chemicals: Mitsui Chemicals (Japan), Sinopec (China).

- Petrochemical Feedstocks: PTT Global Chemical (Thailand), Petronas Chemicals Group (Malaysia).

## 3. Polyurethane (PU)

### Chemical Recycling Methods:

- Glycolysis: Breaks down PU with glycols to yield polyols.

- Hydrolysis: Uses water and heat to recover polyols and amines.

- Pyrolysis: Produces hydrocarbons, isocyanates, and other chemicals.

- Ammonolysis: Breaks PU into polyols and amines using ammonia.

### Resulting Chemicals:

- Polyols: For new PU foams, elastomers, coatings.

- Amines (e.g., MDA): For PU production or other processes.

- Isocyanates: For making new PU products.

- Hydrocarbons and gases: For fuels or feedstocks.

### Possible Products/Materials:

- New PU Foams: Furniture, mattresses, automotive interiors.

- Elastomers: Footwear, seals, industrial components.

- Adhesives and Coatings: For construction, automotive, packaging.

- Insulation Materials: Rigid and flexible foams.

### Companies/Countries in Asia:

- Furniture and Mattresses: Sinomax (China), Hilding Anders (China, Southeast Asia).

- Footwear (Elastomers): Pou Chen Corporation (Taiwan), Feng Tay Group (China, Taiwan).

- Adhesives and Coatings: Henkel (China, India), Nippon Paint (Japan).

- Insulation Materials: Recticel (Malaysia, China), Kingspan (Asia-Pacific).

## 4. Ethylene Vinyl Acetate (EVA)

### Chemical Recycling Methods:

- Pyrolysis: Decomposes EVA into gases, oils, and residues.

- Solvolysis (e.g., methanolysis): Breaks EVA into ethylene and vinyl acetate.

- Hydrolysis: Yields ethylene and vinyl acetate using water and heat.

### Resulting Chemicals:

- Ethylene: For producing new PE or other ethylene-based polymers.

- Vinyl Acetate: For making polyvinyl acetate (PVAc) or polyvinyl alcohol (PVA).

- Acetaldehyde and other small molecules: For chemical processes.

### Possible Products/Materials:

- New EVA Products: Shoe soles, foamed sheets, films.

- PVAc Adhesives and Paints: For industrial and consumer applications.

- Ethylene-based Materials: PE and copolymers.

- Vinyl Alcohol Polymers: Adhesives, coatings, textiles.

### Companies/Countries in Asia:

- Footwear (Shoe Soles): Yue Yuen Industrial Holdings (China), Panarub Group (Indonesia).

- Films and Foamed Sheets: Toray Plastics (Japan, Malaysia), Changzhou Tiansheng New Materials (China).

- Adhesives (PVAc): Pidilite Industries (India), H.B. Fuller (China, Southeast Asia).

- Vinyl Alcohol Polymers: Kuraray (Japan), Sekisui Chemical (Japan).