Common Plastic into Fuels

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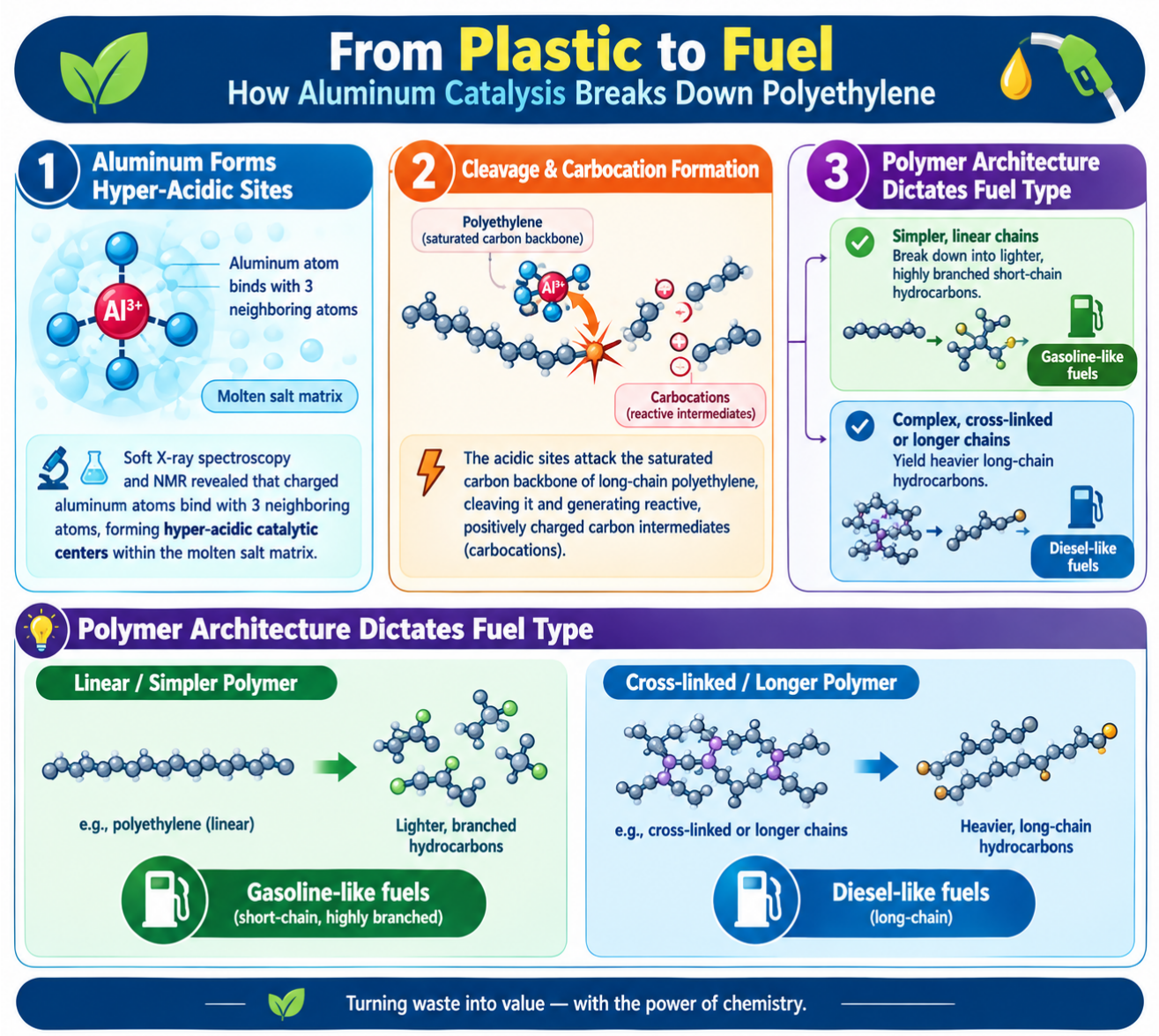
Why in News?

Researchers are recently demonstrating a low-temperature process to convert polyethylene (the world's most common plastic) into gasoline- and diesel-like liquid hydrocarbon fuels with yields reaching ~60%.

- **Target Material -** Focuses on polyethylene, a ubiquitous thermoplastic polymer composed of long, resilient hydrocarbon chains used in shopping bags, food packaging, and cutting boards.
- **Dual-Role Molten Salts -** Utilizes commercially available inorganic molten salts containing aluminum chloride ($AlCl_3$), which serve simultaneously as the solvent medium and the active catalyst.
- **Low Temperatures-** Operates at below 200◦C significantly lower than traditional plastic-to-fuel methodsand requires no external hydrogen gas, noble-metal catalysts, or organic solvents.

Molecular Mechanism

- Soft X-ray spectroscopy and Nuclear Magnetic Resonance (NMR) revealed that charged aluminum atoms bind with 3 neighboring atoms, forming hyper-acidic catalytic centers within the molten salt matrix.
- The acidic sites attack the saturated carbon backbone of long-chain polyethylene, cleaving it and generating reactive, positively charged carbon intermediates (**carbocations**).
- **Polymer Architecture Dictates Fuel Type**
    - **Simpler, linear polymer chains** selectively break down into lighter, highly branched short-chain hydrocarbons (**gasoline-like fuels**).
    - **Complex, cross-linked, or longer polymer structures** yield heavier long-chain hydrocarbons (**diesel-like fuels**).



Feature	Conventional Thermal Pyrolysis	ORNL Molten Salt Process (2026)
Operating Temperature	High (*450*◦C to *500*◦C)	Low (<*200*◦C)
Reaction Medium	Thermal gas phase / vacuum	Inorganic molten salt matrix
Consumables / Additives	Requires noble metals (Pt, Pd) or external H2gas	No noble metals, external H2, or organic solvents
Yield & Selectivity	Broad mix of waxes, gases, and char; low liquid yield	**~60% yield** of gasoline- and diesel-range liquid fuels

Significance

- Offers a viable pathway for **upcycling** low-value plastic waste into high-density energy resources rather than downcycling into inferior-quality plastic products.
- Operating at sub-*200*◦C reduces the energy input required for plastic depolymerization, making industrial-scale plastic-to-fuel plants more economically viable.
- Industrial scaling will depend on developing material confinement systems to prevent reactor corrosion from molten salts and simplify salt recovery and reuse.

Reference

[Business Line | Common plastic into gasoline and diesel-like fuels]