

## Catalytic Microwave Assisted Gasification for Recycling Polymer Matrix Composites

### Innovation

Eltron's CMAG process uses catalysts and fibers that heat when exposed to microwaves.

### Benefits

#### Stronger, Longer Fibers

- No milling/chopping of the composite is required, so full-length fibers are reclaimed
- Reduced liquid/char/tar products leads to better fiber surfaces and stronger second-generation composites
- Low operating temperatures (275-325°C) cause less thermal stress on the fibers

#### More Gas & More H<sub>2</sub>

- Converts the polymer to gas instead of liquid/char/tar
- Gas is high value H<sub>2</sub> and CO instead of the CH<sub>4</sub> and CO<sub>2</sub> seen with other pyrolysis methods

### Stage of Development

- Technical and economic feasibility was shown at the laboratory scale. A laboratory reactor was constructed.

Eltron Research & Development has developed a novel microwave technology to efficiently convert the organic matrix of polymer composites to usable chemicals or fuels without degradation in strength or size reduction of the fibers, allowing the high-value reinforcements to be directly recycled into new composite structures.

Catalytic Microwave Assisted Gasification (CMAG) increases the efficiency of the gasification reaction of the polymer matrix in composites by enhancing the catalytic activity at lower temperatures. As part of our research, Eltron developed new catalysts that act as internal dielectric heaters, resulting in composite recycling that is cheaper and faster. When applied to gasifying fiber-reinforced composites, CMAG encourages more complete gasification of the products to syngas (CO and H<sub>2</sub>), while reducing the liquid and tar byproducts as well as coking.

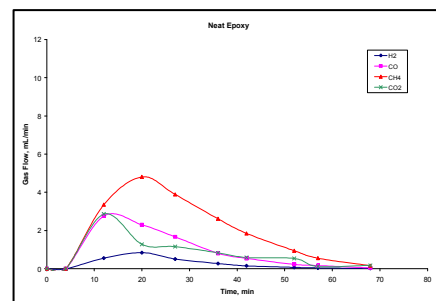
Carbon fiber composites offer an alternative to steel, with comparable stiffness and strength at one-fifth the weight. Currently, fiberglass composites and plastic account for approximately 20% of the weight of a vehicle. Replacing half the steel with carbon fiber composites could reduce vehicle weight by 60%, which would increase fuel economy by 30% and reduce greenhouse gas emissions by 10%–20%.<sup>1</sup>

Historically, composites were considered “unrecyclable” due to the mixture of the polymer matrix with the particle or fiber reinforcements and their thermoset nature. Automotive composites panels, which are often produced with multiple resins or additives, are both expensive and considered especially difficult to recycle. What's needed is technology to reclaim high-value carbon fibers from polymer matrix composites.

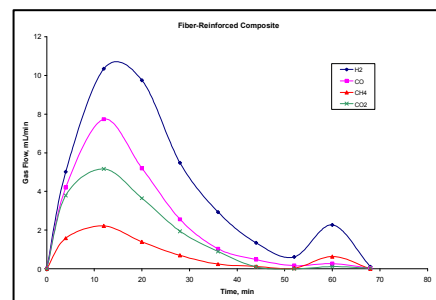
### Stage of Development

Eltron has successfully gasified a full-size carbon-fiber reinforced composite panel which was recycled into a new composite panel. Testing showed that there was no statistically significant difference in the tensile properties between composites containing virgin fibers and full-size, recycled fibers.

An economic analysis of CMAG of polymer matrix composites was conducted, including a cash flow analysis based on costs and revenue. Sensitivities to capital cost, operating cost and reclaimed product



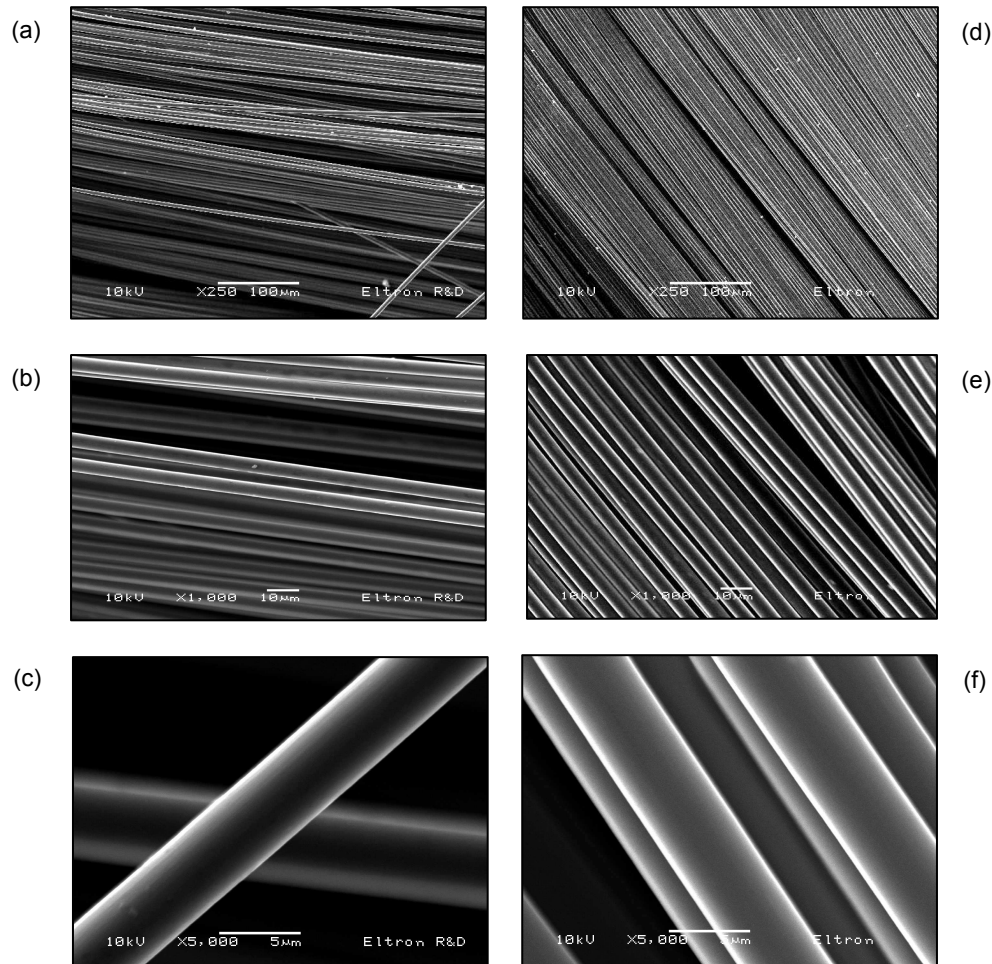
**Figure 1.** High CH<sub>4</sub> and low H<sub>2</sub> content from microwave-assisted gasification **without** catalyst.



**Figure 2.** CMAG of fiber-reinforced composite sample with high H<sub>2</sub> and CO levels.

1. “Carbon fiber cars could put U.S. on highway to efficiency,” Oak Ridge National Laboratory, [http://www.ornl.gov/info/press\\_releases](http://www.ornl.gov/info/press_releases), 2006.

value were developed. Assuming \$5/lb value of the recovered fibers, and no value for scrap composites, a process for converting 4000 lb/day of composite with 65% fiber content was found to be economical at up to a \$9.6 million fixed capital investment cost. The microwave oven and supporting equipment is expected to account for a fraction of this cost.



**Figure 3.** SEM photos of virgin fibers (a, b, c) compared to fibers after CMAG of the polymer matrix (d, e, f).

### Contact Us

To discuss the possibility of entering into a business relationship with Eltron, contact the Business Development Group at [business@eltronresearch.com](mailto:business@eltronresearch.com) or 303-530-0263.



### Eltron Research & Development Inc.

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