Ecocell® – Lighten up!
A revolutionary foaming agent to reduce material and resin consumption

Giving Life to Plastic
Defining new production goals: Experience the new high performance products.

Kafrit Group is a leading producer of Masterbatches and Compounds for the plastics industry and currently employs more than 400 people. In 2017, the Group achieved $216 million turnover with an available capacity of more than 82,000 MT. Moreover, the company is active on a global scale and has set up production sites all over the world. All of this began in 1973 when the company was founded in Israel. Since then, the company has grown primarily via acquisition.

Today, the Kafrit Group incorporates Kafrit Industries (1993) Ltd. in Israel, CONSTAB Polyolefin Additives GmbH in Germany, China’s Suzhou Constab Engineering Plastics Co. LTD, Polyfil Inc. in the USA and the Canada-based Kafrit NA Ltd. With more than 44 years of experience in the plastics processing industry, the company can draw on high levels of expertise and technical know-how. Kafrit Group places a high value on sustainability and has made it a cornerstone of our corporate strategy. Our unbridled dedication to environmental, social and financial issues makes us one of the leading business partners in the plastics industry. Our customers value our passion and appreciate our ecological awareness and social commitment. Moreover, they recognize our world leading services and consider our products as among the best within our industry.

We develop and produce cost-efficient solutions which will enhance the completion of high-quality end products in many areas of the plastics industry, such as packaging films (BOPP, CPP, PE), PC sheet, agricultural films, biopolymers, flame retardant applications, PEX pipes, fibers and nonwovens. Along with many other products, the Kafrit group supplies the following Masterbatches and Compounds:

- Acid Scavengers
- Antiblock
- Antidust
- Antifog
- Antiglare
- Antimicrobial Agents
- Antimist
- Antioxidants
- Antislip
- Antistatic
- Barrier MB
- Cavitating Agents
- Color Concentrates
- Ecocell®
- Flame Retardants
- Fillers
- Foaming Agents
- IR Absorbers
- Light Stabilizers
- Lubricants
- Matting Agents
- Metal Deactivators
- Modifier
- Nucleating Agents
- Optical Brighteners
- Paper-like Compounds
- Peel Compounds
- Processing Aids
- Purge Agents
- Release Agents
- Slip-Antiblock
- Slip-Antistatic
- Slip Agents
- Tracer MB
- UV Absorbers
- UV Blockers
- White Masterbatches
- White Cavitaled

Research that takes us to the top

Throughout our company history, research and development have always been a key area of our expertise. Kafrit employs a staff of more than 400 people that work on innovative products and make use of our vast pool of knowledge that we developed in our 44 years of experience in the plastics industry. Our experts optimize and develop additive concentrates, flame retardants, color concentrates and compounds for various applications. Kafrit enjoys a close partnership with renowned research institutions at the Shenkar University in Israel and at different universities in Germany. Moreover, we maintain a strong cooperation with well-known suppliers including machine manufacturers who recommend our products for use in combination with their machines.

What is Ecocell®?

Ecocell® is a patented technology that infuses microscopic air bubbles throughout the polymer during the conversion of that polymer into a finished item. Ecocell® contains a combination of additives in a pelletized polymer base that when heated above 393°F releases a small quantity of carbon dioxide creating an air-pocket or foam cell in the polymer. The foam cell diameter is usually about 125 microns, and, depending on polymer type and process, sometimes smaller. At this size they are invisible to the naked eye. With Ecocell® it is possible to reduce the density, and thus, resin consumption, by up to 35% using conventional processing equipment and over 50% in processes specifically designed for foaming.

What makes Ecocell® different from traditional Chemical Foaming Agents?

There are 3 features of Ecocell® that make this product different than present day foaming agent technology.

**Formula:** The ingredients used in Ecocell® are different than those used in all the conventional endothenmic and exothermic foaming agents. The by-products are different, there is less water given off upon activation, and the pH is neutral.

**Cell Size:** The cell size of Ecocell® is typically in the range of 100 microns allowing it to be used in processes where
conventional endothermics fall short. The larger cells produced by traditional CFAs have a greater negative effect on appearance, printability, draw down and physical properties. Parts made with Ecocell® are smoother, more opaque, have greater draw down potential and retain physical properties better than conventional systems.

**Activation:** Ecocell® has only one activation point whereas conventional endothermics have two. Ecocell®’s reaction occurs at 393°F (200°C) and matches well to the processing temperatures for the polymers it is intended to be used with. Conventional endothermics have two activation points; one at approximately 320°F and another at approximately 395°F. The first activation temperature usually causes pre-expansion, loss of gas, large cells and cell collapse.

**What can Ecocell® do for me?**

- Reduce material and resin consumption
- Reduce density and part weight
- Reduce molded in stresses
- Remove sink marks in molded items
- Reduce cooling time
- Increase output
- Reduce energy costs
- Create cells in the polymer so that materials act like cellulosic/wood that can be sawed, nailed or screwed
- Eliminate voids
- Eliminate warpage
- Increase opacity and decrease pigment usage
- Produce a pearlescence effect on extruded and blow molded surfaces
- Decreases viscosity and increases flow

**In what applications or processes can I use Ecocell®?**

The following is a list of applications and processes that Ecocell® has successfully been evaluated in:

- Art Board
- Blow Molded Articles for Automotive
- Cast and Blown Films
- Center Core of Building Composites
- Closure Gaskets/Liners
- Coaxial Cable Insulation
- Decorative Ribbon
- Extruded Sheet
- Fiber
- Injection Molding-Automotive etc.
- Structural Foam Molding

**How much do I use?** Ecocell® comes in a pellet form and should be used at 1% to 2.5%. Using it at a lesser amount will cause inconsistent foaming and poor incorporation or mixing into the polymer melt. More than 2.5% may reverse the effects of foaming, over saturate the resin with gas and cause overnucleation where cell walls rupture causing large voids, poor surface and an increase in density.

**How do I mix it with my resin?** Being a pellet, Ecocell® can be used in the normal way one uses a color or additive concentrate. It can be physically blended with the resin or fed at the hopper with a volumetric or gravimetric feeder. It is not recommended that a mix of Ecocell® and resin is vacuum conveyed over long distances as separation will likely occur because of pellet density differences.

**What are the recommended processing temperatures?** The activation temperature of Ecocell® is exactly 393°F (200°C). Somewhere along the process a melt temperature of 393°F (200°C) degrees must be exceeded for the chemical reaction to occur. The foaming process will decrease the viscosity of the molten resin so extrusion temperatures can be set lower than that for unfoamed polymer. It is preferable that the reaction takes place in the highest-pressure areas of the process to keep the evolved carbon dioxide in solution until the material exists the die. This is usually the metering section in a typical extruder. The throat should be below 393°F degrees to prevent pre-activation in this low-pressure area of the process.

**What are the recommended process conditions when using Ecocell®?**

**Sheet and Profile Extrusion**

*Temperature:* A typical temperature profile for low or high density polyethylene, polypropylene or polystyrene is as follows:
<table>
<thead>
<tr>
<th>Section</th>
<th>Temperature °F</th>
<th>Temperature °C</th>
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<tbody>
<tr>
<td>Feed</td>
<td>385</td>
<td>196</td>
</tr>
<tr>
<td>Transition</td>
<td>395</td>
<td>201</td>
</tr>
<tr>
<td>Metering</td>
<td>420</td>
<td>215</td>
</tr>
<tr>
<td>Die</td>
<td>390</td>
<td>199</td>
</tr>
</tbody>
</table>

In this profile the die is set below the activation temperature of the Ecocell® to produce the smoothest surface possible by preventing additional activation on the surface of the extrudate. The feed is set below the activation temperature to prevent pre-foaming and the transition section is set high enough to begin melting of the polymer while building pressure. The metering zone is preferably where most of the activation of the Ecocell® takes place and where pressure is high enough to keep the CO2 in solution and prevent expansion of the polymer until it exits the die.

**Screw RPM:** To prevent activation and, thus, foam expansion from occurring too soon, an RPM setting of 25-30 or above is recommended. The higher pressure and lower residence time caused by high extruder speed is desirable.

**Cooling:** It is uncommon to require any special cooling methods other than that used for cooling unfoamed polymers. Contrary to popular belief, the foamed polymer will cool faster than solid material as there is less mass and the melt temperature exiting the die is cooler due to the endothermic nature of the chemical reaction.

**Die Gap and Drawdown:** It is desirable to keep drawdown of the polymer exiting the die to a minimum. Drawing down the polymer after it exits the die will elongate the cells causing thinning of the cell walls and possible cell collapse and rough surfaces. Foam expansion actually occurs outside the die so if die gap adjustments are not made to accommodate this, the drawdown could present a problem. Through experience, we recommend using the following formulation to determine what die gap is ideal to minimize drawdown.

\[
\text{Die Gap} = (1 - (D_t / 3)) \times T
\]

where:
- \( D_t \) = Desired weight or density reduction
- \( T \) = Target thickness of the finished sheet or film

Example: A weight reduction of 30% is desired in a 60 mil thick sheet

\[
D_t = 30\%
\]

\[
T = .060 \text{ inches}
\]

\[
\text{Die Gap} = ((1 - 0.3/3)) \times .060
\]

\[
= (1 - 0.1) \times .060
\]

\[
= .9 \times .060
\]

\[
= .054
\]

In this example the die gap should be set to 54 mils to obtain a 30% weight reduction in a 60 mil sheet.

**Post Extrusion and Thermoforming**

The same methods used to print, corona treat, laminate, cut, etc. solid/unfoamed polymer materials should be used for foamed materials as well. Because there is a reduction in mass, many of these post extrusion processes will see an advantage obtained by foaming with Ecocell®. Materials will be easier to cut (extending knife wear), and it is usually necessary to reduce oven temperatures when thermoforming.

**Blown and Cast Films**

It is well to note that foaming films will reduce some properties greater than the corresponding weight or density reduction achieved. Tear strength in the machine direction, dart impact and tensile strength will be adversely affected and it is recommended that films foamed with Ecocell® are used only in non-load applications or applications able to withstand the decrease in physical properties.

**Resin choice** is an important factor in determining the quality of the foamed film. For obtaining a film with the smallest foam cells and best weight reduction, a conventional low density polyethylene is recommended. Linear low density polyethylenes appear to produce larger cells with a greater chance of blow through and cell collapse. The following photographs at 30X show the cell morphology in different resins.

- **Ecocell® in Low Density Polyethylene**
- **Ecocell® in Linear Low Density PE**
Ecocell® in a blend of LDPE and LLDPE

The Extrusion profile for foamed or cast films is similar to that of extruded sheet as follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>Temperature °F</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>395</td>
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<tr>
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<td>201</td>
</tr>
<tr>
<td>Metering</td>
<td>420</td>
<td>215</td>
</tr>
<tr>
<td>Die</td>
<td>390</td>
<td>199</td>
</tr>
</tbody>
</table>

These temperatures are guidelines and can be changed depending on the situation. The foaming process will decrease the viscosity of the molten resin so extrusion temperatures can be set lower than that for unfoamed polymer. The temperatures above take into consideration the 393°F decomposition of Ecocell®. The concept is to prevent activation of the Ecocell® until it reaches the high pressure section of the metering zone keeping the CO2 in solution and preventing expansion until the material exits the die.

**Screw RPM:** As in other extrusion processes an RPM setting of 25-30 or above is recommended to prevent activation and, thus, foam expansion from occurring too soon. Higher pressure and lower residence time caused by high extruder speed is desirable.

**Screen Pack:** Screens of 40 mesh and higher are recommended and, contrary to popular belief, the pressure drop across the breaker plate is not so critical as long as the pressure forward of the metering zone maintains or exceeds 1000 PSI.

**Die gap and draw down:** To maximize properties, prevent cell elongation, and to keep the cells small, minimizing draw down is critical. In films, the experience has been to keep the draw down under 10:1 for cast film applications and 20:1 in blown film applications. Larger drawdown ratios can be employed but cell elongation with aspect ratios of 3:1 or higher are likely. This will further reduce properties, especially tear strength in the machine direction. A 0.040 inch die gap was used to produce the cell structure in the 2 mil films shown in the previous pictures.

### Injection Molding

The injection molding process presents some limitations to the processor who is considering the use of Ecocell® to reduce material usage. Part thickness, gating, mold design etc. all impact the potential weight reduction in a part. However, Ecocell® offers other advantages besides weight reduction for the molder such as:

- Elimination of sink marks
- Reduction in cooling time due to the endothermic nature of Ecocell's chemical reaction.
- Reduction and Elimination of warpage.
- Reduction of molded-in stresses
- Elimination of voids via nucleation (see below)

#### Ecocell™ Nucleation

In regards to weight reduction, it has generally been considered that parts with a thickness below .125 inches are too thin to achieve any appreciable weight savings due to high fill pressures and small gating. However, in many cases Ecocell® has reduced part weight up to 10% in parts as thin as .060 inches. Often it is just a matter of evaluating Ecocell® in the process to determine weight savings. General recommendations to improve the potential for weight reduction are to reduce flow length by center gating the part, have the flow of the material go from thin to thick, use as large a gate size as possible and supply generous venting.
**Processing Temperatures:** A typical temperature profile for molding polyethylene, polypropylene or polystyrene is as follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>Temperature °F</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 (hopper)</td>
<td>390</td>
<td>199</td>
</tr>
<tr>
<td>Zone 2</td>
<td>420</td>
<td>216</td>
</tr>
<tr>
<td>Zone 3</td>
<td>420</td>
<td>216</td>
</tr>
<tr>
<td>Nozzle</td>
<td>380</td>
<td>199</td>
</tr>
</tbody>
</table>

In this profile, zone 1 is set below the decomposition temperature of the Ecocell® to prevent pre-activation and the nozzle is set colder to reduce drool. A shut off nozzle is preferred but not necessary.

**Additional process recommendations:** Fill rate should be a maximum of 4 seconds, there should be no hold pressure or cushion since this will collapse the cells as they are forming, and shot size should be adjusted for the expansion of the polymer. To adjust shot size, decrease the amount of fill until a short shot is obtained and then increase the shot size minimally so a full shot is achieved.

Pressure between 25 and 30 PSI is ideal. Both blow rate and blow pressure are variables that the processor should investigate to maximize weight reduction. Also, a generous amount of Ecocell® may be added to obtain maximum weight reduction as the Ecocell® is less prone to parison blow through than typical endothermic blowing agents because of its very small cell size.

**Other**

Ecocell® has successfully been evaluated in fiber applications. It has also seen success as a nucleant in physically foamed systems. As more processing information regarding these applications is gathered, we will make it available to our customers.

Polyfill Corporation offers technical assistance if you are looking to trial Ecocell® at your facility. You can contact us at our offices or contact your account representative to learn more about Polyfill’s Ecocell® Technology.

**About Polyfill Incorporated-A member of the Kafrit Group**

Polyfill began operations in 1984. It is ISO 9001 certified and is the largest independent manufacturer focusing solely on the development and production of performance enhancing additive concentrates for polyolefins. Besides Ecocell® and foaming agents, its product line includes multi-functional additive concentrates, gas and odor absorbers, clarifier/nucleators, UV and AO stabilizers, amine, non-amine and non-amide anti-static agents, mineral filled concentrates, anti-oxidants, purge and shutdown compounds, processing aids, release agents, slip, anti-blocks and custom formulated concentrates.

Polyfill’s 60,000 square foot manufacturing and laboratory facility is located in Northern New Jersey. This modern facility allows Polyfill to produce, affordable, high quality additive concentrates.

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