CERAMIC REINFORCED TECHNOLOGIES

CERFLON® and CERTEX™ FluoroCeramic Chemistry

What is CERFLON® and "**Why**" CERFLON®? Booklet

A Guide and Manual

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Ceramic Reinforced Technologies Mission and Value Statement

- Ceramic Reinforced Technologies offers CERFLON® high performance lubricant additives based on the synergistic effect between colloidal dispersions of Boron Nitride and PTFE. CERFLON® provides a lower coefficient of friction, improved wear, high temperature protection and residual protection ("memory effect") when added to a lubricant.

- Adoption will be driven by the development of cost effective products that offer improved properties, greater durability longer change intervals) and no environmental issues for the next generation lubricants.

- Sustainability will be driven by large market demand for improved efficiency, lower operating cost, durability (longer change intervals) and no environmental issues for the automobile, truck, heavy equipment and industrial lubricant markets.

- At Ceramic Reinforced Technologies, we are differentiated by our dispersion stability, compatibility with other ingredients and ability to rapidly respond with new products to meet customer demands.

Section I: What is CERFLON® and **Why** CERFLON®? Booklet

A simple definition:

Bor▪on Ni▪tride (cer▪am▪ic) re▪in▪force▪ed flu▪o▪ro▪pol▪y▪mer

A Boron Nitride ceramic reinforced fluoropolymer occurs when Boron Nitride is added to a fluoropolymer in a carrier.

It is as broad and simple as that…. and it is patented!

"Ceramic Reinforced Fluoropolymer" - United States Patent 5,783,308

Patent Abstract

A dispersion including at least one carrier, from about 0.1 to about 20.0 weight percent of at least one particulate fluoropolymer and from about 0.1 to about 20.0 weight percent of at least one particulate boron nitride, the dispersion being useful as a coating to give a ceramic reinforced fluoropolymer substrate.

And, it can use the United States trademarks CERFLON® and CERTEX™

"Given that a large portion of demand in the fluoropolymer market will be driven by an increasing need for high-performance materials for specific application formulations and chemical processing, CERFLON®***, a ceramically reinforced fluoropolymer, can play a significant role."***

So, what is CERFLON®?

CERFLON® is a ceramic reinforced fluoropolymer. Fluoropolymers are a unique class of plastics known for their excellent heat and chemical resistance. They consist of very long chains of carbon atoms either fully or partially surrounded by fluorine. The carbon-fluorine bond is one of the strongest chemical bonds known. Fluoropolymers are used in a wide range of applications in chemical process, electronics and life sciences industries.

A reinforced fluoropolymer occurs when Boron Nitride, which is stronger and more durable, is introduced into the matrix of the fluoropolymer as a filler thereby reinforcing the polymer. The addition of very fine particles of Boron Nitride significantly increases the durability and/or wear properties in both films and coatings of a fluoropolymer. This increase in durability also provides a longer lasting lubrication benefit. Additionally, since Boron Nitride is, by itself, an excellent lubricating agent, the fluoropolymer acts as a binder to improve the adhesion of both fluoropolymer and Boron Nitride on surfaces that require boundary lubrication.

The surface energy and chemical reactivity of Polytetrafluoroethylene (PTFE) and Boron Nitride are similar in nature, and this allows the dispersion of Boron Nitride within PTFE. The ability to be dispersed improves the homogeneity of the composite formed, leading to more uniform properties at lower loadings. Further, Boron Nitride is the only material known to fully wet certain fluoropolymers, in particular PTFE, thereby increasing its ability to act as a reinforcing material when compared to other materials.

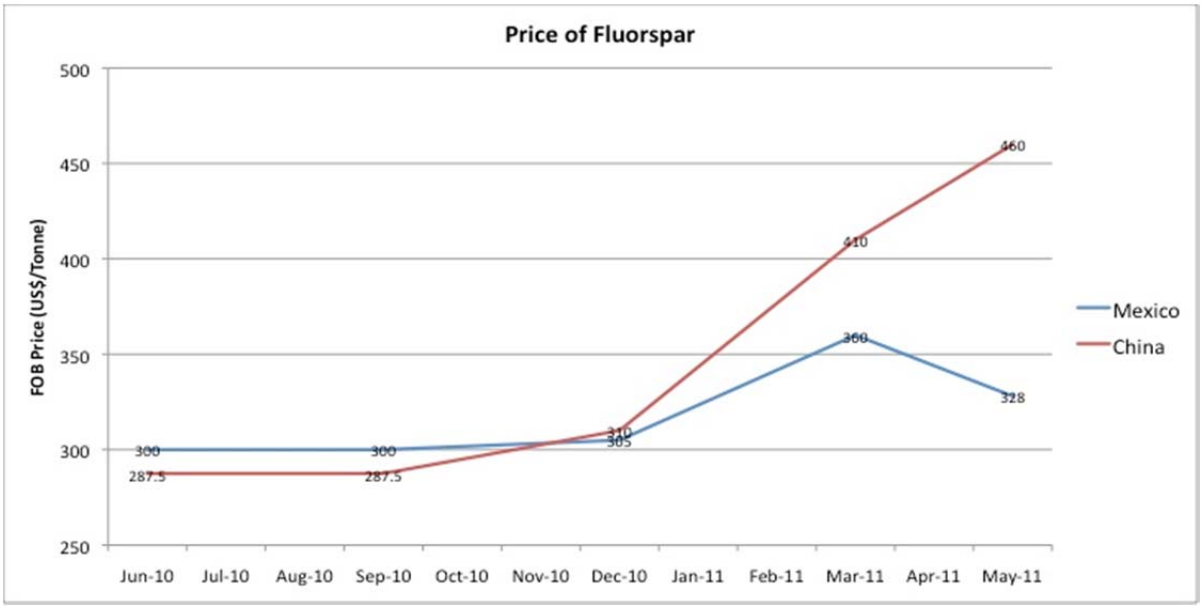
Traditionally, many inorganic materials have been added to PTFE to improve its thermo-mechanical properties such as glass fiber, carbon, and metal powders. However, the amount of material required to achieve the same effects as seen with Boron Nitride is substantially higher. This can furthermore cause property compromises and increased costs. Additionally, the majority of these fillers have significantly higher surface energy and chemical reactivity when compared to PTFE. Reinforcing of PTFE by reactive, high surface energy fillers is sub-optimum due to ineffective bonding between the reinforcing material and PTFE due to poor wetting.

Boron Nitride reinforcement assures that the electrical properties and the reactivity of the composite remain unchanged, regardless of the amount of filler applied. Thus, fluoropolymers reinforced with Boron Nitride have a much broader and useful application range.

"While Boron Nitride in fluoropolymers or CERFLON® has always represented a good value proposition, recent raw material conditions, specifically with Fluorspar, has made an even more interesting proposition for Boron Nitride in fluoropolymers".

So, why CERFLON® now?

Fluorspar is a naturally occurring mineral, used in a multitude of industries ranging from metallurgy, ceramics, glass, aluminum and – fluoropolymers. As there have been significant price increases in Fluorspar over the last few years the impact on PTFE pricing has been significant. The graph below shows the price increases in China and Mexico. Even though Fluorspar is less expensive in Mexico, the volumes in China are much higher which implies that the global price follows their price trend more closely.



A $1/Kg increase in the price of Fluorspar increases the cost of TFE by $2.6/Kg. Another factor creating higher PTFE prices is a lack of availability of Fluorspar, so industry experts do not see any significant easing of prices anytime soon.

So, now for the even better CERFLON® value proposition….

Ceramic Reinforced Technologies (CRT) thought that BN represented a good value proposition for enhanced PTFE properties when PTFE was about $8-10/lb; now it is $16-18/lb and in some grades well above $20/lb. As PTFE reached these price levels, its costs become almost 70% of the cost of BN. You will see later on in this document that ladder studies conducted by which demonstrated that PTFE:BN at an 80:20 ratio is a "sweet spot" for most lubrication applications. With that being the case, the economics for PTFE:BN FluoroCeramic powders are now even more compelling. Further, so as to be very application specific, there can also be different ratios and these would also have little incremental cost difference. CERFLON® FluoroCeramic powders will be unique, protected, and differentiated powders from commodity PTFE and therefore not a commodity.

FluoroCeramic Cerflon® Benefits

1. They are unique! In other words, nobody else has the right to sell them and only Ceramic Reinforced Technologies LLC controls that fact.
2. Just in the USA, there is close to a $.5B PTFE market that will look at an enhanced PTFE with the additional properties that Boron Nitride brings to PTFE, and that is FluoroCeramic **CERFLON®** powders and dispersions.
3. The total USA fluoropolymer market is $1.6B and the demand for commodity fluoropolymers is growing at 4.5% through 2013. So with less than a 1% market penetration for FluoroCeramic **CERFLON®** powders and dispersions this will generate $16MM in revenue. If there was an exclusive fluoropolymer company marketing these powders and dispersions, there could also be a very significant market share shift.
4. In the case of Perfluoropolyether (PFPE) greases and oils, FluoroCeramic **CERFLON®** powders and dispersions provide valuable additional properties and are extremely cost effective.
5. The price is right! Boron Nitride now has minimal cost impact in making a ceramically reinforced and therefore enhanced PTFE.
6. And, FluoroCeramic **CERFLON®** powders and dispersions are not commodities!
7. There are also significant marketing advantages available when using FluoroCeramic chemistry to enhance today's commodity fluoropolymers.
8. The "Ceramic Reinforced Fluoropolymer" US 5,783,308 patent means that FluoroCeramic **CERFLON®** powders and dispersions are patent protected.
9. **CERFLON®** is a registered trademark thereby protected and **CERTEX™** (read Gore-Tex®) is also a CRT trademark.
10. **CERFLON®** is the "next generation" Teflon®.

An Illustration of Market Scale Opportunities for BN in Fluoropolymers

Fluoropolymers - A US Industry Study with Forecasts FOR 2013 & 2018

Demand in the USA for fluoropolymers will rise 4.5 percent per year to $1.7 billion in 2013. Gains will represent an increase from the pace of the 2003-2008 periods, during which the fluoropolymer market was hampered by weakness in the manufacturing sector. Going forward, fluoropolymer demand will be driven by a turnaround in key markets such as motor vehicles, wire and cable, and the increasing need for high-performance materials in chemical processing applications. Demand in emerging, fast-growing markets such as advanced batteries, fuel cells and photovoltaic modules will also support fluoropolymer market gains**.** ***Fluoropolymer volume demand will rise 3.6 percent per year to 172 million pounds in 2013.***

Fluoroelastomers, smaller volume types to lead gains

PTFE	**27%**
Other Fluoropolymers	**21%**
FEP	**18%**
Fluoroelastomers	**18%**
PVDF	**16%**

Polytetrafluoroethylene (PTFE), the first commercial fluoropolymer, will continue to account for the largest portion of demand in 2013. Advances for PTFE will be driven by growing opportunities in applications such as chemical processing and industrial filtration. However, the most rapid gains will be seen in fluoroelastomers, fueled by a strong rebound in motor vehicle production from a low 2008 base. Demand for fluorinated ethylene propylene (FEP) and polyvinylidene fluoride (PVDF) resins will rise at a more moderate pace, limited by a drop in nonresidential construction activity. Nonetheless, volume gains for these resins will exceed three percent per year, outpacing growth in real manufacturing activity over the same period. Robust gains will also be found in smaller-volume fluoropolymer products, which include a number of high value materials used in emerging markets. Double-digit growth in solar energy products will fuel gains for polyvinyl fluoride (PVF) films used in the production of photovoltaic modules. Demand for perfluorosulfonic acid polymers (such as DuPont's NAFION) will be driven by the rapid rise in fuel cell production. Additionally, a strong pharmaceutical market will bolster demand for polychlorotrifluoroethylene (PCTFE) polymers, which are used in drug packaging films.

Film additives to be fastest growing applications

Among fluoropolymer applications, coatings and liners and mechanical components were the largest uses in 2008, comprising three-quarters of total demand. However, faster gains are expected for fluoropolymer film ***and for fluoropolymer additives, which impart enhanced thermal stability*** and nonstick properties to products such as plastics, elastomers, lubricants, and coatings. ***Demand will be driven by the increasing need for high-performance materials in chemical processing, and rising demand in emerging, fast-growing markets.***