HIGH VALUE FIBERS
What They Are And What Makes Them High Value

Introduction

In order to discuss high value fibers, we need to first develop a definition of "high value", and then determine the factors that make a synthetic fiber have high value. A simple definition for a high value fiber is one that has a selling price much greater than the cost of the raw materials. In fact, there are really two categories of high value fibers. One is differentiated products which typically sell for one to several times the cost of the polymer and specialty fibers which typically sell for over five times the cost of the polymers used to make the fiber.

There are a number of factors which are involved in determining the selling price of a fiber, as there are for any product. The most basic law of capitalistic economics is that the selling price will balance the supply and demand of any product. Anytime the balance between supply and demand is changed, the selling price of the product will automatically be raised or lowered until the balance is restored. The demand for a fiber is based on it perceived value in its end use versus its cost. For a medical end use, such as a biodegradable heart suture, the value of the end use is almost infinite; whereas for apparel the value of a fiber is perceived to be low. These perceived values can change quite rapidly and come from many sources such as a marketing effort, introduction of other functionally equivalent products, standard of living, etc. A good example is PET fibers which were introduced into the market in the 1950's. These fibers has a selling price of over $20 per pound in 2000 dollars. The same fiber today sells for less than $1 per pound. What drove the price of the polyester in 1950 was its introduction as a "miracle fiber" that lasted forever and was wrinkle free without ironing. The supply was low, the demand and subsequent price were high. Although the demand for the fiber has increased at an astounding rate world wide in the last 50 years, the supply has increased at an even faster rate. This has been possible because the technology to make polyester fibers has become will known and the cost of conversion from polymer to fiber has also decreased rapidly. Therefore, there have been few barriers to entry for increased capacity other than investment cost.

Another factor that affects the selling price of a fiber is differentiation. In this case, the fibers made from the same polymer are modified to give a different set of properties or the polymer is modified to give a differentiated set of properties. If these different properties are in demand, then a new supply/demand balance, and therefore a new selling price, can be established. If the supply can be controlled then the selling price can be kept high. This can be accomplished (at least for a limited time) by barriers to entry such as patents, in-house technologies, high investment cost, qualification requirements, litigation potential, etc.

Large Volume High Value Fibers

There are a number of high value fibers that are presently in the market place, with significant volumes and many somemore being introduced. Many of these fall into the category of differentiated products and some are specialty fibers. Many different processes are used to produce them. Some are melt spun, some are solvent spun, and others such as carbon and ceramic fibers, are made with more complex technologies. Examples of large volume differentiated melt spun fibers are solution dyed fibers, sheath/core and bicomponent fibers, as well as high modules, low shrink industrial fibers. Examples of specialty, very high value fibers with modest market volume that are melt spun are fibers made from fluoropolymers, splittable and dissolvable bicomponent fibers, biodegradable fibers for medical uses, polyolefin membrane exchangers, and structural color fibers.

High value fibers that are solvent spun include Kevlar® and similar polyamide fibers, PBI fibers, Nomex and spandex elastomerics. The cost and technology to produce solvent spun fibers such as these is quite high which acts as a substantial barrier to entry of new capacity of these fibers and helps to keep the selling price high. Much R&D work has been aimed at designing new technology to manufacture fibers similar to these at lower cost. Much of this work has centered on finding technology to produce such fibers by melt spinning. In the case of spandex or elastomeric fibers, several new spinning technologies have been developed and patents on older processes are expiring. Because of this spandex fibers have dropped from the specialty category to the differential category.

Hollow fiber membranes can be produced by other solvent spinning or melt spinning, but are generally considered in a separate category since these fibers function as a membrane and not a fiber. Most of these products are made from polysulfone, acrylic, cellulose acetate or polyolefins. Applications include reverse osmosis, blood dialysis, ultra filtration for water and other liquids, and gas separation. The functionality is based primarily on the porosity and pore size of the wall of the hollow fiber.

Large Volume and New Speciality Fibers

There are a number of other potential fibers that are presently in a research or development stage that if commercialized will initially be high value. Two of these attempt to reduce the cost of manufacturing by developing a melt spinning process for fibers that are normally produced by solvent spinning. Examples of this are melt spinnable elastomerics and melt spinnable acrylics. Other types of meltspun fibers that are likely to be commercialized in the near future have optical or microwave carrying capability (these may be a fiber within a fiber), submicron sized fibers, and fibers that react with the body or environment. This last group of fibers can be used for improved comfort or protection against air borne chemicals or pathogens. Two newer developments are phase change materials spun directly into PET and fibers with large void areas where a water soluble material has been leached from the fiber.

In the solvent spun area, development work is being done by a number of companies and universities to make high strength fibers from spider drag silk which has a strength/weight potential close to 3 x that of Kevlar. Similar research is underway to develop medical products from fibers produced from natural proteins such as chitosan and alginate. Other projects are attempting to commercialize new high strength but heat resistant fibers similar to PBI and to spin fibers with electrical conductive properties close to those of metals. A new development is this area is the ability to melt spin a metal in the core of a thermoplastic fiber.

In the membrane area, work is being done in the medical area to develop hollow fiber membranes to help in cancer treatment, removal of cholesterol from blood, and manufacturing of synthetic body organs. Others are working to develop fiber membrane that can be used in separation of undesirable products from natural gas, such as hydrogen sulfide.

As the future unfolds, we will see many new specialty fibers and new polymers such as PLA, PBT, PTT, etc being commercialized. Most of these will start their life cycle as specialty products with high value. Many will stay in that category, but many others, like polyester, will simply increase in supply and demand, beginning as a ‘miracle fiber’ and after many years become a commodity.

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