# BORON: FROM SCOURING POWDER TO FLY RODS

By Don Phillips

*(Don Phillips has justifiably been called the "Father of the Boron Rod", for he did the pioneering stress calculations and holds patents for solid boron and boron hybrid fabrication. His restless search for excellence, the fact that he produces his unique rods at home, reminds one so much of an earlier master rod builder that one might be forgiven for calling him the "Everett Garrison of the Spage-Age Fly Rod". We welcome his contribution.—Associate Editor.)*

ALTHOUGH boron is just beginning to substantially penetrate the fishing rod market, fibers of this material have been available to the world aerospace industry since the mid-1960's. In this period of my professional career I was directly involved with converting the process for making boron fibers; scaling up a research activity to a production operation.

Boron is one of nature's fundamental elements, found most plentifully in the compound borax, which has been mined from near Death Valley in California, U.S.A., for about a century. Borax, technically known as a hydrated sodium borate, is a common scouring powder and cleansing compound, but it can also be processed to form boron trichloride, a compound used in the U.S. chemical industry.

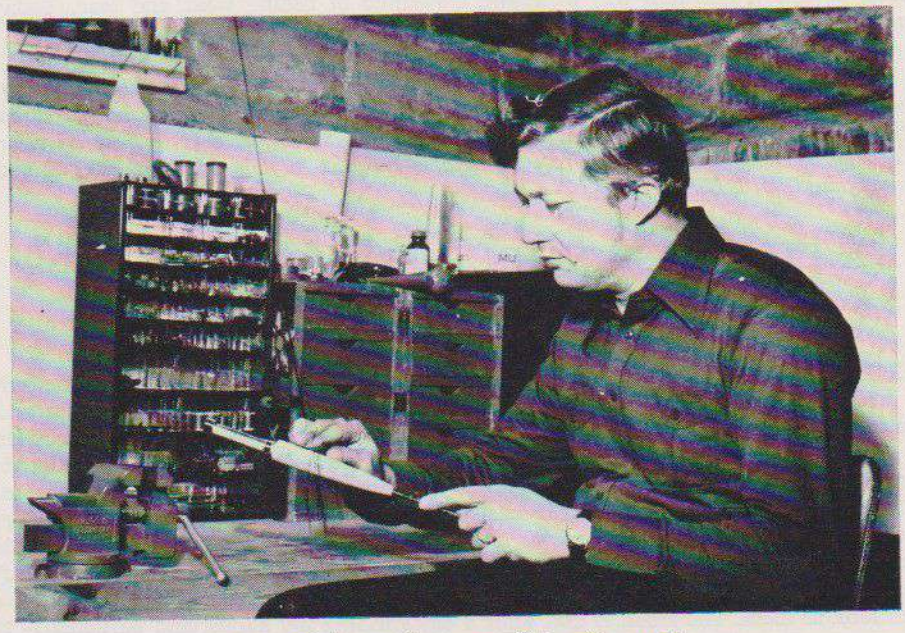
Ultra high-strength fibers of boron are produced by chemical vapor deposition, wherein boron trichloride gas is passed over a very fine, electrically-heated tungsten wire. Boron fibers are now being produced in continuous lengths in several different diameters by Composite Technology Inc., in Broad Brook, Connecticut, and by AVCO Speciality Materials in Lowell, Massachusetts. Boron fibers have exceptional physical properties when used in composite structures because of the higher fiber strength and stiffness and the extremely intimate bonding that occurs between the fibers' corncob-like exterior surface and the surrounding matrix material.

Long before I had ever heard of boron, I was a dedicated fly fisherman, wading the streams of New England in search of wild trout. The application of boron fibers to fly rods seemed a perfect match, and in January 1972 I began a personal commitment to develop boron fly rods by combining my engineering and fly fishing skills. The following ten years have been exciting, hectic, frustrating, and at the same time rewarding. All the manufacturers who said it couldn't be done are now doing it themselves. I believe that they have only scratched the surface of boron's potential for fishing rods.

Boron fibers are used by most fishing rod manufacturers in a manner very similar to the processes involving graphite or fiberglass rods. In fact, most boron fishing rods actually incorporate more fibers of graphite or fiberglass than boron. Essentially, all of these processes involve the wrapping of a resin-impregnated fibrous tape pattern over a tapered steel mandrel. After oven curing the mandrel is removed, resulting in the conventional hollow construction. All-boron construction is difficult in hollow rods because this extremely stiff material must be used sparingly in sections requiring substantial flexibility, such as in rod tips. The resulting thin wall sections have a tendency to collapse under high bending stresses. The mixing of other, less stiff fibers permits a thicker wall section with less fragility, while still taking advantage of boron's exceptional attributes of strength, stiffness and hardness. Since starting my experimentation in 1972, I have employed a solid construction. Initially, this approach was for lack of access to expensive steel mandrels; however, the smaller diameter solid rod does reduce fiber stresses, lowers wind resistance and eliminates wall collapse due to bending or lateral cruhing.

Contruction of my solid boron fly rods involves the lateral wrapping of a boron-reinforced epoxy tape pattern around a permanent boron fiber mandrel. The tape contains hundreds of parallel boron fibers, all running the length of the tape pattern. The

blank is cured in a high temperature oven, under tension, until the epoxy has hardened to its maximum strength. In this unique method all fibers remain exactly parallel to the central mandrel; a configuration which is the most efficient for achieving bending stiffness and for minimizing residual fiber stress after curing. Hollow tapered fly rods cannot achieve this parallel feature. Although I consider these rods to be developed, I am continuing to experiment and improve them. A few cosmetic details have yet to be perfected, and these are currently occupying a significant extent of my experimental effort.



**Don Phillips making one of his unique rods.**

*Photograph by Eddie Herbst*

Other manufacturers have been reluctant to follow my method of construction, because the large amount of boron and the extensive hand labor would result in a selling price which only the wealthy can afford. I operate a one-man shop in my basement and this low overhead approach and philosophy permit me to make these rods available at competitive prices.

In spite of heavy pressure from my customers, I have to decline all requests to make fly rods longer than 9 feet or heavier than for 6-weight lines. My experimentation has clearly shown that the solid construction results in too much weight and insufficient crispness of action as the rods get longer and more powerful. There are competent rod manufacturers who are capable of providing satisfactory all-boron rods in these longer lengths and higher line weights, using hollow construction.

Boron is truly a high performance fiber that has significant potential for the fishing rod industry. Unfortunately, there are several financial factors that may limit the widespread use of the fiber over the near future. First, boron has a current price of $250 per pound, many times the price of graphite or fiberglass. Second, the uniquely high stiffness and hardness of the fiber make it totally unlike any existing material; therefore, automation (to reduce costs) will itself be very expensive. Finally, the structural proper-

ties of boron are such that a certain amount of sophistication is required to design each rod, so that the advantages of boron are most fully utilized, and so that sufficient structural integrity is maintained.

All of these factors may inhibit manufacturers from investing in the development of all-boron fly rods, or may result in high rod prices which only few anglers can afford. Hopefully, the rod companies will be equal to these formidable challenges and will develop and produce advanced boron fly rods at affordable prices. I personally plan to participate in the innovative activities required to bring this to fruition. The payoff is not just newer and different fly rods, but fly rods that will cast further and with greater accuracy, and that will withstand a lifetime of fishing wear and tear. Today's boron offerings demonstrate the promise of this space age material.

*(Don Phillips produces rods ranging from a six-foot for a two-weight line to a nine-foot for a five-weight line. He offers a unique warranty; if a rod section breaks within one year from delivery, for any reason, it will be replaced (one time only) free of charge. Write to him at: FlyCraft Associates Inc., 52 Suffield Meadow Dr., Suffield, Connecticut* 06078, *U.S.A.)*