Water-Break-Free

A further treatise on proper surface preparation for optimum bonding.

by Ralph O'Quinn

A simple test with a bit of water can tell us a great deal about how well we are preparing our surfaces for bonding.

The phrase "Water Break Free" is familiar to anyone working in the plating or most metal painting industries. It is a common terminology used to describe the optimum cleanness of a surface that has been obtained prior to the surface receiving a chemical treatment, such as anodizing or plating. This water break free condition is observed after the surface has been subjected to various solvent degreasing and alkaline cleaning solutions and is being rinsed with clean – usually deionized water. If the water breaks free across the surface, all is well and we proceed to the next operation. But sometimes the water will not break free, it will bead up or draw back from the edges in spots, indicating a contamination of some sort and the cleaning operation is repeated until the water breaks free in the rinsing operation.

So what does all this have to do with building fishing rods? Fishing rods don't get anodized or plated except for a tiny percentage of the total area such as our guide frames, metal reel seats, some hosels, and maybe an odd ball butt cap here and there. But those areas are already taken care of, there is nothing that we need do – it's already been done by the manufacturer. Nevertheless that same "water break free" concept used by the anodizing people can be a very important guide in putting together a quality rod.

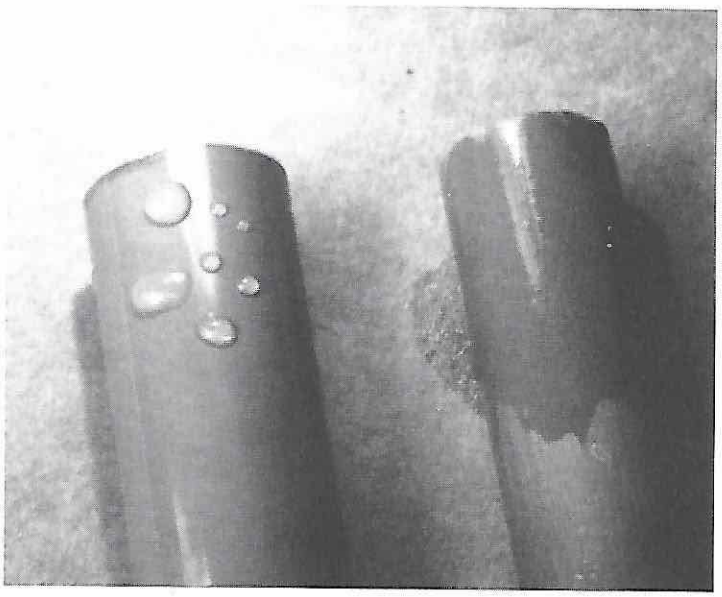
Most of the bonding that we do as rod builders is done in conjunction with the blank itself. Reel seats, handles, ferrules and most butt caps, involve the blank and it is this entity that sees the most abuse by well intentioned but badly misinformed individuals who insist on mutilating and generally tearing up perfectly good structure. They do this in the belief they are doing the right thing. Actually any gouging, scraping, filing, etc of a blank's surface will greatly reduce the strength and integrity of the bond that follows.

Surface Area

Any bonding agent - call it a glue, adhesive or whatever - is intended to be worked over a wide area. Bonds are never concentrated such as is a rivet or a bolt, except when dealing with something like jewelry in which case it is not bonding, it is merely gluing. As an example, suppose we take two pieces of thin sheet metal about 4 inches square, super impose them one on the other, drill a few holes and rivet them together, leaving an inch or two on the sides for holding purposes. No matter how many rivets we install in the thin metal, when exhorted to a pulling force the rivets merely tear out at a very low load.

Now take the same setup, only bond the two together with a good metal bond system. There's no way you can separate the two without tearing the metal itself at a high load. The bond has distributed the load throughout the

The optimum condition for bonding surfaces is one which is referred to as "water-break-free". In such a condition, water will spread out evenly rather than beading, breaking apart or attempting to withdraw from the surface.



These photos illustrate the difference between the supplied surfaces of new rod blanks (left) and the surfaces of blanks which have been properly prepared (right) and are now considered in "water-break-free" condition.

entire bonded area, while the rivets took only point load resulting in failure of the structure at each rivet. When you gouge through the surface of a fiberglass or graphite rod blank, then bond to that area, you have effectively punched a rivet or two in the structure, at the point where you gouged it, and the structure will fail at that point and under very low load.

When bonding to a rod blank, be it graphite or fiberglass, the surface resin must not be penetrated. The surface of the blank is composed first of a clear coating/paint, then under that coating is a layer of the resin that binds the blank together. You are not hurting the integrity of the blank by removing part or even all of the outer coating. Bonding directly to the underlying resin will still give optimum conditions. However if this outer layer of resin is removed by filing, grinding, judicious sanding, or whatever - you are now bonding directly to the glass or graphite fibers, and this is where you simulate punching a rivet. This is the condition that leads to catastrophic failures and in preventing this condition is where our knowledge of "water break free" surfaces comes into play.

Preparing The Surface

It is a simple matter for us to obtain this surface condition. We do it with an abrasive material called Scotchbrite made by the 3M company. There is no true substitute for this particular item that I am aware of. Scotchbrite comes in many grades and grits just like sandpaper. The ones we use for our rodbuilding are Type-S-7448 Grey-ultra fine and Type-S-7446 Grey-medium fine. Always use the ultra fine when you don't want any scratches to show and use the medium fine when scratches don't matter and you want faster abrasion/preparation such as on reel seats and handles.

Now you need to teach yourself just how much abrasion is necessary in order to obtain the proper bonding surface. Find a piece of rod blank and the larger the diameter the better. Hold one end of the blank under a dripping water faucet. Note the water on the blank, or rather note that you can hardly get the blank wet as water simply will not stay on the blank surface.

Now just to prove a point, judiciously clean a portion of the blank with an alcohol solvent. Rub vigorously, clean it real good. Now test it under the dripping faucet again. Any change in the water pattern? So much for using a solvent as a final cleaning agent.

Now if you have some handy, take a piece of Scotchbrite medium-fine and abrade away all the shine on a section of the test rod blank. When all shine is removed and you have a dull and finely abraded surface, test it under the dripping faucet again. Note that now the water spreads across the blank surface and wets the entire area. There may be spots where the water tends to peel back from its own edges. If so, a little more vigorous abrading in those areas will correct it. You now have a "water break free" surface and the absolute optimum that the average home owner/rod builder can obtain for his bonding surface.

Try the same thing on a Fuji reel seat. Drip a drop of water on the metal plated hoods; note how it beads up and runs off. Now polish the metal with some ultra-fine Scotchbrite and repeat the test. The water now will wet out the entire polished area. When you are getting water break free surfaces you are getting good bonding surfaces. (NOTE: a word of caution on using tap water for this test.

If you live in an area that has hard water for your tap water, usually water not suitable for drinking, it may not be suitable for testing. Deionized water is used in industry - it is treated so that the water contains no more than 15ppm (parts per-million) of dissolved solids. If your tap water contains any more than about 150 ppm the water is not suitable for a good water break free test and you should get some bottled water for this job.)

You can also get satisfactory water break free surfaces with some other abrasive mediums. Silicon Carbide grit sandpaper in 400 to 600 grade will give good preparations. It can be tested via the water break free method and will look about the same as when using Scotchbrite. But Scotchbrite has another advantage which is little published, probably forgotten in history, but very important in our operations. Remember when you took high school physics and the teacher rubbed a long acrylic rod with a piece of rabbit fur and the ensuing static charge was enough to ring a bell or light a bulb or some such thing? Scotchbrite does a similar thing to the abraded surface. It causes a realignment of the surface molecular structure which is a great enhancement to bond integrity. This was first demonstrated by a Russian physicist in the middle 1950's. You do not get this re-alignment with sandpaper, steel wool or any other known abrasive medium. The more wet looking the surface, i.e. the better the "water break free" condition, the better the bond will be.

Solvents

Probably the greatest evil ever created in our rod building world is the belief that solvents are to be used for cleaning purposes, especially all the wrong solvents. Ketones, especially Acetone, have no place in our rod building world. When solvents are to be used, never use anything stronger than the alcohols. But never under any circumstances use any solvent as a final operation prior to bonding or painting.

The judicious use of solvents is responsible for more witch hunts than any other single operation in our arsenal. Solvents are far over-rated in what they can do and far under-rated in the harm they do. The very best they can do for us is to minimize and re-distribute contaminants prior to another operation.

However there is another operation seldom mentioned and hardly ever used in rod building that is far and away superior to anything except scotchbrite on fiberglass/graphite structure and that is the Alkaline/abrasive cleaners. A very long expensive test program lasting about 6 months was once conducted in the aerospace world to determine just exactly what we wanted to know - how to bond to an airframe fail safe structure consisting of epoxy-fiberglass. The program concluded that the alkaline/abrasives are the answer. I am talking about common household cleaners. A product called "Old Dutch Cleanser" was found to be the very best of the best. Another product called "Ajax" was found to be the very baddest of the bad. The difference between the two is mainly in the grit. Ajax is actually too abrasive and cut through the outer layer of resin resulting in weak bonding. "Old Dutch Cleanser" was found to be the perfect cleaner and abrasive and most of the other brands fell somewhere in between.

In the absence of Scotchbrite, Old Dutch Cleanser, or a similar brand, will do an admirable job in cleaning your rod components for bonding. Just stay away from the solvents except maybe as a first preliminary operation.

Bond Failure

When determining the strength of a particular bonding system, the test pieces are tested to destruction, usually in shear. The bond strength is noted, but more important than final strength to the test engineer is the MODE of failure of the bond. Bonds will fail in one of two different modes or a combination of the two. There is a cohesive failure mode and an adhesive failure. The cohesive failure is always to be desired and this is when the bond fails within the adhesive itself and leaves an equal amount of adhesive on both separated surfaces. An adhesive failure means that the bond failed by stripping loose from the substrate, leaving a shiny surface on one side and all the adhesive clinging to the other surface. Within the same bonding system, adhesive failures are always much lower in value than cohesive failures. Adhesive failures mean the structure is subject to fatigue failure, moisture attack and premature failure under a no load condition and all the many mundane conditions that plague poor bonding.

Testing

By duplicating this testing for yourself you will gain confidence in your ability to obtain a "water break free" surface. Take another piece of your blank test section, mix up a paste adhesive, or use your thread coating epoxy if necessary, and apply it to a small area. About 1/2" x 1" is about right. Apply it to one area without doing anything to clean it. Then another area where you solvent cleaned it only, then another area where you Scotchbrite abrade the area and another area where you cleaned with a household abrasive cleaner. Let the adhesives cure for a few days, then pick at them with a sharp probe of some kind and observe the way the adhesive clings to the rod in each case. You should see a total adhesive failure in the first two and complete cohesive failure in the second two.

The Flip Side

There is a flip side to this coin. Like any coin it has a heads and tails. We have looked at the heads side of the coin – how about the tails? Does anybody out there have any idea how many production rods are made each year? I'm thinking about the worldwide manufacturing of millions of them. No way do any of those rods see any Scotchbrite or sandpaper or even solvent cleaning before installation of a handle or reel seat or whatever. The manufacturers have never heard of water break free nor do they care. Seats and handles and all components are slapped together helter skelter breaking every rule in the books in order to get them out the door. It's my guess that they probably have no more than a 1% failure percentage in all those millions of badly put together rods. It is unlikely that they could live with more than about 2% returns.

To prove a point to some doubting Thomas's, I once waxed an entire rod blank with a car wax, polished it real good and made up the rod – a medium weight fresh water spin rod. The predecessor of Rod Bond, one of the experimental batches, was used to bond the handle and reel seat. I used Flexcoat and the old Duragloss on the guides. The rod came out normal, no one could tell there was anything different about it. At first I couldn't break the handle by twisting on it, but finally managed to shear the cork at about the mid-point between the reel seat and the butt. It showed complete adhesive failure but would still have lasted for many years I'm sure. I thought I was going to fail the blank itself I had to twist so hard! None of the guides wanted to twist off and I broke one of them before giving up on all of them! So much for the necessity of good clean surfaces!

But this side of the coin sends the wrong message to many people. Just because such poorly prepared and bonded surfaces seemed to hold up intially can be misleading. I know for a positive fact that this rod would see problems in about a year due to moisture-creep under the bond and the fatigue factor. All of us are familiar with loose reel seats on production rods. I have taken apart many of them and on examination they ALL exhibit adhesive failure against the blank section and all have only about 10% to about 50% of the total mating areas bonded – instead of 100%.

I think that most reel seats, at least fresh water reel seats, would stay in place forever with only about a 10% or 20% bonded area if the bond exhibited a cohesive failure mode to a water break free surface. And as custom rod builders this is the kind of workmanship that separates us from the mass market. It is our job to prepare and bond 100% off the mating surfaces in the proper fashion. It is both quick and easy to do now that we know how.

Testing

Now take a piece of your sample rod section and perform this test in order to gain confidence in your future surface preparations.

1. Briskly solvent wipe the area to be bonded and subject it to the water break free test. Note the wetting condition.

2. Now lightly sand a section of the blank with something on the order of #400 grit wet or dry sandpaper and note the water pattern again.

3. Now briskly polish that sanded section with your Scotchbrite and again note the break free pattern. Now as a final insult to injury, vigorously clean your #3 area with your favorite solvent. In a perfect world you should obtain in order of performance:

1. No change in water break free pattern from the original.

2. Should show a good wetting of the surface, but not as good as -

3. The absolute optimum that is possible to obtain. When you now attempt to clean this optimum surface with a solvent you will experience a considerable loss in wetting condition and the water break free surface will show some beading.

In summary our sequence for optimum bonding to rod blank surfaces is:

1. Clean the surface with a light solvent i.e. alcohol, either IPA or denatured. When using a solvent for cleaning never allow the solvent to dry on the surface being cleaned. Always rub the solvent in a cleaning motion then wipe dry with a separate rag.

2. Lightly abrade the surface with a fine grit sandpaper until it is dull in texture.

3. Briskly abrade the sanded area with Scotchbrite until it is uniformly smoothed.

4. Bond your surfaces.

In most cases you can omit the second step. Instead, merely abrade the surface with the Scotchbrite but teach yourself how much to abrade. You must remove the shine plus a little more, enough to make the surface uniformly dull and smooth.