

Friction Focus: Pads & Rotors

Subaru vehicles just keep getting better and better, as you've probably noticed. So, that old saw, "They don't build them like they used to," just keeps getting more and more untrue and irrelevant with every model year. Regardless, there's one service area where you're probably doing just as much work as you ever did: brake friction components, namely, of course, pads and rotors.

There's a lot to this topic, and the deeper your understanding of it is, the happier your customers will be with the services you provide, and the more profitable your shop will become. So, it should be well worth your time to read the following.

Material Boy

The quest for the ideal friction material has been sort of like a drawn out version of Thomas Edison's search for a suitable light bulb filament. All kinds of things have been tried for at least 120 years.

The spoon brakes used on the first cars usually had wooden blocks, but they were sometimes supplemented with a leather lining. Band type brakes were either metal to metal, or used wood or leather, too. The earliest drum stoppers (invented by Louis Renault in 1903) had iron shoes against steel, then some strange materials were used, such as the walrus hide linings of the English Wolseley.

The credit for first taking a scientific approach to friction materials goes to an Englishman, Herbert Froad. Using a water wheel powered friction test machine, Froad experimented with numerous materials (even cotton!) and bonding agents. In 1908, he hit upon resin impregnated woven asbestos reinforced with brass wire, and the era of safe stopping began.



Before we go any further, we'd better get a term straightened out. In the brake business, asbestos linings are called "organic," which is really a misnomer since only something of or derived from living organisms fits the dictionary definition of the word. But it's applied to asbestos because it occurs naturally. Now, with all kinds of unusual materials being used, organic has come to mean anything that's not metallic.

The "A" Word

Through eight decades, asbestos proved itself to be a very serviceable friction material. But it has a couple of drawbacks that were to spell its demise. One, it's been linked to lung disease, accurate or not. And, two, its friction characteristics go away in severe braking situations resulting in the scary phenomenon you probably know of as "fade." That's why sintered iron linings (you could call them "full mets") were found in some heavy duty applications. They stopped great once hot, but it took strong legs to get any appreciable deceleration when they were cold.

The automakers aren't permitting asbestos anymore, so responsible brake manufacturers got the stuff out of their plants years ago.

But there's more to the story. With smaller brakes doing more work, a new friction material was badly needed anyway. So, we got semi-mets. Basically, these are steel wool, iron powder, and other metal particles molded together with a phenolic resin binder. They're great at handling heat, and normally last a long time. One brake authority mentions another factor that puts the thermal situation into perspective: "A fundamental fact that many technicians don't realize is that semi-mets are designed primarily to get the heat out of the rotor. In other words, if you were to put on a set of organic pads, you'd guarantee that the rotor would be ruined. Another expert puts it this way: "Asbestos was a good insulator, whereas semi-mets absorb, then dissipate heat."

Early semi-met recipes had big problems with noise, tended to eat rotors, and made huge amounts of dust that stuck to those nice alloy rims. But today's formulas are quieter, less aggressive and cleaner. That is, providing they're given the proper surface to work with and are broken in right, subjects we'll get to shortly.

Although semi-mets were pretty much universal on front discs for years, today there are two other friction materials on the scene, namely non-asbestos, non-semi-met linings, called "NAO" (Non Asbestos Organic there's that term again), and ceramics. All kinds of mixtures containing such things as aramid/Kevlar, fiberglass, carbon fiber, nut shells, different kinds of metal particles, etc. are either already on the market or in development, the goals being long wear, good friction characteristics, preservation of rotors and drums, quiet oper-



Brakes do their job by converting kinetic mechanical energy into thermal energy. Ergo, pads and rotors get hot. Whenever you get a case of uneven wear or pulling that might be due to drag, using a non-contact infra-red pyrometer will help nail down the problem.

ation, and reduced dusting. By the way, most later models with rear drum brakes had NAO linings on their shoes.

Given the continuous improvement in friction materials (who can keep up?) and the importance of using the right stuff for the particular car at hand, does it make sense to buy anything but original equipment pads (and drum brake shoes, for that matter) from SOA? That's the only way you can be sure you're getting what that model was designed to use. The price is very competitive with the aftermarket friction your local jobber supplies, but the peace-of-mind factor is vastly superior.

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Will you get the perfect shims and the right grease with aftermarket pads? Not bloody likely. Only Subaru original equipment lining sets have everything you need to do the job exactly right.



The finish quality of the caliper wear inserts from a genuine Subaru pad set speaks for itself.

Another factor in this buying decision is the completeness of the pad sets you purchase. Nobody but SOA is going to give you exactly the right pad shims and other hardware, which will go a long way in preventing comebacks for such things as squeal and dragging brakes.

Smooth Moves

The changes in lining material have made rotor finish much more critical than it was in the old days of asbestos. Some experts say that getting this right will eliminate 80% of noise complaints. Smoothness is the rule. Where 80 100 RMS was once considered correct, now 40 60 RMS is recommended. In other words, if you were using an off-car lathe you'd finish up the machining job with a non directional swirl using 120 to 150 grit paper instead of the traditional 80. Unfortunately, as one brake expert tells us, "Generally, we find that when rotors are resurfaced in the field, they have a 150 to 175 RMS finish. New rotors will probably be in the 30 40 RMS range, which is hard to achieve with the average shop lathe. Some people get confused about this because new rotors come with a directional finish. What's important is the fineness of the finish. Adding that non directional swirl with an abrasive is a means to an end." Of course, the on-car lathe that Subaru

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If you're going to machine a rotor, as opposed to replacing it or letting it be, you can't do better than with a quality on-car lathe, such as this Pro-Cut unit, which SOA recommends.

recommends will produce the ideal finish if handled properly (more on that later).

You may want to check for the proper level of smoothness with a surface comparitor gauge, the same thing that's commonly used to verify that engine cylinders and head sealing surfaces are okay.

Hands Off?

While it bucks tradition, we'll go on record as saying that it's sometimes best to leave those discs alone. As one brake service expert says, "If the rotors aren't in bad shape and there's no complaint, why refinish them? There isn't a whole lot of extra meat to take off today. And it's better to use them as they are than to do a fast cut that leaves a rough finish." A successful Subaru specialist tells us, "I'm not a big fan of turning Subaru rotors because you tend to go through the hardening. We know that from the racing program we're involved in. After they're cut, they'll fissure on you. With customers' cars, we let the rotors go as long as possible the scoring doesn't seem to contribute much to squealing."

Many brake authorities are telling us brake lathes are essentially obsolete. During normal pad replacement, they say, use the discs as-is providing the grooves aren't deeper than .060 in. If those unintentional concentric furrows exceed that limit, replacement is the remedy. Some even go so far as to say that in high-pedal-effort situations, you should buy new rotors if the originals have ever been turned.

This is also an attractive route on older Subaru cars that have "captive" rotors. Just make sure you keep your standards high. Don't try to go with discs that really aren't acceptable.

But, just as with everything else in life, there's another side to the story. First, how is any professional going to explain to his patrons why his is practically the only shop in the galaxy that doesn't turn rotors? And should he charge less for a reline? Maybe he should. Or, he may opt to apply the saved machining time to closer inspection of lines, hoses, hardware, etc., or to changing the brake fluid, and keep his price the same.

On-Car

In the early 1990s, pedal pulsation and squeal comebacks were reaching plague proportions with all automakers, bar none, under warranty and thereafter. And it seemed to be getting worse every year.

Subaru service engineers decided to go pro-active here. They stepped back and did a careful assessment of all the possible causes of these customer complaints, then investigated potential cures. Friction formulations were scrupulously examined, and the issues of runout (techs would have to start making sure the hub/disc interface was perfectly clean) and lug tightening practices (no more cranking them on there with your gun set at max, and use the pattern!) were also given due consideration.

While this attention to detail helped, it wasn't the profoundly certain answer that Subaru was looking for. The only sure-fire way to eliminate runout in the assembly is to use an on-car brake lathe, which will resurface discs with excruciating accuracy "in situ." The high-quality Pro-Cut lathe was the one SOA approved.



Right: Where tightening lug nuts is concerned, it's NO on the impact gun, which can cause the wobble that eventually results in thickness variation and pedal pulsation. Use a torque wrench.

So, if you're getting tired of brake pulsation and squeal comebacks, and maybe have a considerable number of customers with older captive-rotor cars, you might want to investigate the Pro-Cut machine. It's not cheap, but it can make your shop the undisputed brake trouble terminator in your town.

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Leaning Toward Replacement

There's a trend afoot that makes much of the above discussion irrelevant. That is, the revolutionary idea of replacing rotors rather than machining them. This decision is often made for you when you mic the disc because it's already approaching throw-away thickness. In fact, if wear equivalent to what was lost during the last lining cycle will result in a rotor that's too thin for service, it's definitely a good idea to explain the situation to your customer and to recommend new discs. Since the quality of the aftermarket brands available varies wildly, the only way you can have confidence that the parts you install won't result in a pulsation complaint is to use original equipment rotors from SOA. Of course, you still must make sure the hub flange is clean so you won't introduce a mounting error.

By the way, don't worry about the anti-rust coating on new discs — just leave it.



Taking the time to clean up the contact areas of the caliper and its mounting bracket will help prevent dragging and uneven wear.

Break-In

Noise and a hard pedal will be likely if proper lining break in procedures aren't observed with modern friction materials. In fact, several experts we've talked to say that overlooking this procedure is the #1 cause of those complaints. As one puts it, "It's not unusual to see a perfectly good brake job ruined in the first five minutes by improper break in."

We know people who still believe that the right way to seat linings is to really stand on the brakes a few times. That's an anachronistic idea left over from the days when linings were supplied "green." Panic stops would indeed get that friction material hot enough to cure it. But you don't get uncooked pads and shoes from Subaru, or from any other manufacturer these days, for that matter, so this whole idea belongs to a bygone era, a time of ignition points and bias ply tires. It's only of historical interest today, certainly not anything you'd want to actually do.

The ideal way to start new linings off is to make 30 slow stops (spaced two minutes apart) from about 30 mph using light to moderate pressure. But nobody who works in a typical bustling shop is going to take that much time. A more practical policy here is at least 10 moderate stops at 30-second intervals (you should be able to feel the action smooth out). Then avoid heavy braking for the first 200 miles.

Details

We'll conclude with some helpful hints:

- It wouldn't hurt to apply a light coat of molybdenum or silicone grease between the shims and the pads. Just be careful not to get any on the linings.
- Make sure you put back any pad shims you took out. But don't assume that because you found none there aren't supposed to be any — the last tech may have left out these sound reducers. Check the manual, and do whatever you have to to get the right parts. Of course, you could've bought a Subaru original equipment pad set in the first place.
- Proper caliper installation is important. Clean and lube the mounting bolts/pins, and sliding contact areas, and torque fasteners to specs.
- For rotor finishes, if you've become used to the RA (Roughness Average) scale, the conversion is $RMS = RA \times 1.11$.
- Regardless of the kind of machining/refinishing procedure used, or even if none is used at all, that disc must be washed. Otherwise, hard particles will become embedded

in the new linings and you'll get noise and scoring. But aerosol brake cleaner is decidedly NOT the answer. As one expert tells us, "If you spray brake cleaner on the rotor, then take a white cloth and rub it on the surface, you'll see nothing but metal filings and particles. And water is a lot cheaper than brake cleaner, so we wash rotors using dish detergent."

- An easy way to measure the depth of a rotor groove is to use a dime. If the top of Roosevelt's head is showing, it's less than 0.060 in. deep.
- Use the proper tightening pattern on wheel lugs, and keep your torque wrench handy. ■

Right: If you don't want to expend the time and effort of using a torque wrench on lug nuts, at least put a torque stick between your gun and the nut, and observe the proper tightening pattern.

