WA Technology

Installing Reduced Dusting Brake Pads

Loved my Z51 2014 Stingray! Braking was as exciting as the acceleration. However, the dust created by the high-performance OEM pads (pic left) required cleaning the wheels several times a week after three ~35-mile round trips to town! Installing ceramic pads solved the dust problem.

Was not going to tolerate waiting a year to replace the pads with the new Grand Sport as I did the 2014 Z51; bought ceramic pads ready to install when the car got home. Changed pads the first day! (Pic upper right)

Carbotech Ceramic Pads:

With all the positive forum comments about the performance and low dusting of the "Made in US" Carbotech 1521 Ceramic Pads and the fact that I do not track, they fit my needs. Here are some published characteristics:

"Carbotech 1521 pads are a high-performance street compound with very low dusting, low noise, and excellent initial bite." **The latter is very important for street pads while race compounds are often required to be hot to achieve maximum braking force.** ***This compound's excellent linear torque production provides incredible braking force without ABS intervention. The pads provide good release and modulation and are rotor friendly. The operating range is from ambient to 800 F*** **(Note have seen 900 F listed as well.)** ***It has excellent linear torque production providing incredible braking force."***

PowerStop Extreme Z26 Pads

Would have purchased Carbotech 1521's for the new Grand Sport but the PowerStop pads were significantly cheaper and forum members said were low dust. Would have preferred using what I knew worked and for this critical item, "Made in the USA" but the cost difference was just too great so thought I would try. I did, for 900 miles than removed them and replaced with Carbotech 1521s!

My Observations

A benefit I found with Carbotech over the OEM pads in my 2014 C7 Z51 was they stopped better than the OEM pads when cold. No such benefit with Powerstop! In fact, in general found they required more peddle force and were not as liner in stopping power versus peddle force. That was another benefit I had found with Carbotech 1521s, they had a better initial bit than even the Z51 OEM pads.

The last straw was a forum poster showed pics of his rotors after using Powerstop Z26 pads for a year. They were discolored! Someone suggested the stain was due to the pad copper content. I recent conversation from person knowledge about brake pads said it could be iron. My rotors were not discolored but in only 900 miles and there was an obvious and tenacious brown stain in all the rotor grooves.

Turns out, copper is an inexpensive way to transfer heat away from ceramic pads. However, it can also contaminate the friction surface on the rotor reducing friction levels. Iron can contaminate the rotor surface and cause brown rust. In addition, it contaminates the environment so some Western States are lowering the allowable copper levels in brake pads to 0.5%. More about copper and its issues as well as iron contamination in raw materials in the Appendix.

Trial Was Over! Bought Carbotech 1521 Brake Pads!

Detailed install info is presented for the Carbotech pads as the early 2014 C7 Z51 had a double sided, high temperature tape used between the front pads and the pistons. It made the removal of the OEM pads more difficult.

Investigated the C7 pad replacement, which I thought would be a snap since these are fixed calipers and with the Vette's racing heritage should have quick pad replacements. Remove two pins, slip out the old pads, clean the caliper, and slip in the new. Well the rear pads were exactly that way. If you have a 2015 the same with those front pads. But we "lucky" folks with early 2014's have to deal with the use of high temperature, very strong, double sided tape holding the pads to the pistons! This tape is used in Europe to reduce noise chances.

This *"Picture Install"* is designed for the occasional DIY person who, like me, doesn't have recent expectance changing brake pads.

It was a year replacing the 2014 OEM C7 Z51 pads with Carbotech 1521 pads so spent time removing the residue brake pad material from the rotors. With only 30 miles on my Grand Sport brakes before installing the Powerstop Z26 pads nothing was needed. When replacing the Powerstop pads with Carbotech 1521's on the Grand Sport with only 900 miles so little cleaning was needed.

The following is the order of info presented:

1. **Installation of Carbotech 1521 Pads on the Grand Sport when removing Powerstop Z26 Pads**
2. **Installing Carbotech 1521 pads on My 2014 C7 Z51**
3. **Installing the Powerstop Pads in My GS**
4. **Appendix: Includes brake pad raw materials issues. Data to show why cold Carbotech 1521 pads stop better than PowerStop with cold pads. Also, other Corvette Forum member posted comments of similar inferior PowerStop cold pad performance. A recent finding about brake pad pin install is also presented.**

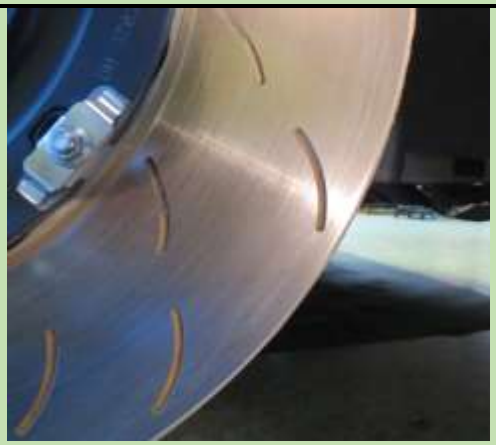
Carbotech 1521 Pads Replace Powerstop Z26 Pads on Grand Sport

Main reasons:

1. **Bettering stopping with cold pads**
2. **More linear braking pressure**
3. **No rotor staining**

Objective Info Presented First

***A poster Wecker3, put this picture on the forum*. He had installed PowerStop Z26 pads on his C7 Corvette about a year prior to seeing this significant rotor discoloring. He had been in contact with Powerstop but was awaiting an answer. Someone suggested it could be caused by excess copper; another perhaps iron in the pads.**



Although after 900 miles my Grand Sport rotors weren't discolored there was a brown residual in the groves in that short time!

Would that transfer to the rotors?

Researching pad material, it will build on the rotors and excess copper could turn them brown!

Frankly the biggest concern I have with critical products from China is quality consistency.

Submerged Arc Welding Flux

I managed a welding materials R&D laboratory developing Argon based shielding gases, welding wire and welding fluxes (sand looking "stuff" in pic.)

One raw material we used was Bauxite. It's the ceramic type ore that aluminum is made from. We were very careful to use ore from sources that had low, what were called "tramp elements." Mother nature seldom makes pure ores. They all come with contaminants.

We bought mostly from Australia but could have purchased Chinese Bauxite much cheaper. However, it had variable contaminant levels that would affect the weld quality. Could not risk the variability.

WHY I CHANGED BRAKE PADS

Need Good Stopping With Cold Pads

Most performance brake pads are designed to stop great when hot. My situation is a bit unique, I live 2 miles down a narrow, twisty 25 mph speed limit road that exits onto a 4-lane divided highway. After blending into 65 mph traffic, in ~100 yards I make a right turn onto another rural road with traffic coming up fast behind. I made that turn very quickly with my C7, Z51 having no issues with the Carbotech 1521s stopping better than with the OEM pads. The Powerstops required more peddle force and did not make me feel confident achieving a high "g" stop. Particularly an issue if there was a car stopped waiting to enter the highway as there was little space!

Similar issue returning home, if the brakes are cool, must leave 65 mph traffic and make a right-hand turn to our 25 mph limit narrow road! (Red Line in Pic.)

Experience with Carbotech Pads: **The day after the install and bedding, tried the cold pad stop, while the Powerstops were fresh in my mind. Definitely better and more confident.**

After over 100 trips through the fast turn with cold pads, the Carbotech pads are even better than my C7 Z51! They should be they are larger! Stops are superior and more predictable to those with the Powerstop pads. I made those stops with very hard braking as there was no risk and felt very confident. Braking is very predictable.

These are the tools assembled to install the Carbotech brake pads. Key items are a 5/32 drift, jack pad, and Ceramic brake lub. Planned to use the pail to catch the alcohol I would use to clean the rotors. Also bought 3M 60 grit sanding pads. Had several items to clean the brown material from the rotor slots depending on how difficult it was. A torque wrench is essential.

A Dremel tool with a small steel wire wheel was needed to remove the brown residual in the slots.

It was not the dark black color of the Powerstop pads. It may be an iron impurity in one of the pad raw materials. In 900 miles deposits were in the slots but could be over the rotor with more miles.

Rotors were shinny after 3 yrs on C7 Z51.

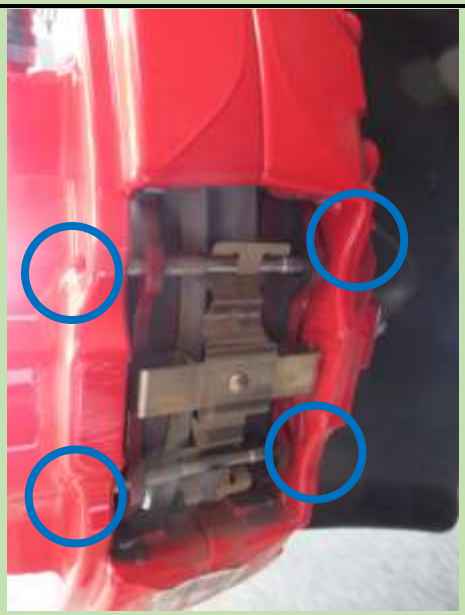
This is a rear rotor with the two slots on the left cleaned with the Dremel small rotary wire brush. The two slots on the right had a brown stain after only 900 miles with Powerstop Pads.

It came out as a fine powdery dust.

Did each groove on the front of the rotors. Hopefully that material left in the rear will do no harm. Never saw this material from the Carbotech 1521 pads in over 2 1/2 years they were on my 2014 Z51.

These are the width of the pads on the Grand Sport:

OEM Brembo = 0.625 Thick
Powerstop Z26 = 0.617 Thick
Carbotech 1521 = 0.630Thick
With Carbotech replacing Powerstop needed 0.013 inch more space. A stiff 0.06-inch-thick paint scraper placed between the Powerstop pads and rotor provided the extra space to make the pads slip-in!



See Page 25 For Tip Installing Pins

This is the rear pad. Punch out the pins with a 5/32 drift if you have one. If not the solid end of a 5/32 drill bit works fine.

Just keep track of the way the parts came off and put them back the same way. I put "up and top" with a Sharpie on the spring in case there was a question about which end went where!

Note: Bedded the pads using the recommended procedure:

1. Brake hard from 60mph to 30mph.

2. Repeat step # 1, 5 or 6 times.

3. Let your brakes cool for about 2-3 minutes while driving, without stopping.

4. Allow the brake pads and discs to cool down to ambient temperature (driving about 20 to 30 minutes without stopping).

Installing Carbotech 1521 Pads on A Year Old 2014 C7 Z51.

Before starting I asked a number of questions on the forum. On one post, I inserted this pic and I asked for experience with Brakleen, which warns not to use on *"painted surface."* The can warning was reinforced with a pic; *"*it said *don't!"*

Someone suggested if using only with a rag where needed, don't spray- *good idea!*

I have always used the 3M product shown to remove adhesive decals etc. on cars, works fine. Rubbing alcohol was another thought.

Someone said start with soap and water! *Another good idea.*

I used all 4 cleaning products since I had a year of accumulated "stuff" and the OEM brake pad residual on the rotors had to be removed! Rotor surface was fine.

First, I used Dawn dishwashing detergent and water. That removed most of the external grime since the C7 has only 4000 miles.

Then I soaked the top of the strong taped joint with 3M adhesive cleaner. Did that several times. Then, as suggested, when the pads were removed used the Brakleen very carefully on the inside of the caliper and wiped down the rotor before sanding. After its use, I quickly rinsed it off with an ample quantity of alcohol.

Brakleen will harm the caliper paint -SO BE CAREFUL! AVOID USING IF YOU CAN. ALCOHOL IS PREFERRED AND WILL DO NO HARM.

The first step is to simply drive out the two pins that hold the pads in place.

Had asked on the forum *"Why there was no mention of the threaded pin ends I expected would retain then in the caliper?"* A response indicated they were simply retained with a special pressure spring arrangement. Described below.

After taping them in the ~1/16 inch they protrude, used drift pin of the correct size, 5/32 inches, which was long enough to get the spring clip retainer out of its recess.

Note the small vise grip used to fully remove the pin. Also note the position of the Cross Spring; it goes back in the same way.

If you don't have a 5/32-inch diameter drift pin, you could use a 5/32-inch diameter drill bit to drive the pointed end of the pin into the caliper. That end sticks out about 1/16 inches so a larger drift pin or small hammer will get it flush with the caliper surface. Then use the drift or round drill end to drive it though the outside of the caliper. It does not take much force.

The pins will have brake residue stuck to the exposed surfaces, as noted in the pic. It came off easily with some 400-grit sand paper.

The Cross Spring helps keep the pads away from the rotor and reduces any rattle when they are not activated. The front and rear are different shapes. Just put them back the way they came off.

Where I was expecting a threaded end on the pin, the C7 uses these split rings to provide tension to retain them. Like a roll pin, they have a larger OD than the recess they slip into. Great for racing to make a quick pad change (once the OEM pads with their sticky tape are removed and replaced with true racing pads!)

NOTE: See page 25 for a tip on installing the pins

NOTE THIS STEP IS ONLY NEEDED FOR EARLY 2014 FRONT PADS.

GM used a very strong, hi-temp, double sided tape between the front pads and the pistons- It is apparently commonly used in Europe. There is no special information about removing pads the Service Manual. Checked with a friend who has a 6 bay auto repair shop. He had never encountered this tape.

Before trying to separate the front pads from the strong, tape that holds them to the pistons, squirted this 3M Adhesive Remover on top of that location. I often use it as a general cleaner before using tough-up paint or removing adhesive. I called 3M since they make double sided tape used on brake pads and they thought it should be a help. When I brought up the possible use of the 3M Adhesive Remover I use for other applications the 3M tech just said, "perhaps it will help."

I used it several times even after a few initial blows with the stiff paint scraper (see below.) It may have helped, not sure.

Now The Tough Part! Removing The Pads, Stuck to the Pistons with Very Strong, Double Sided Tape!

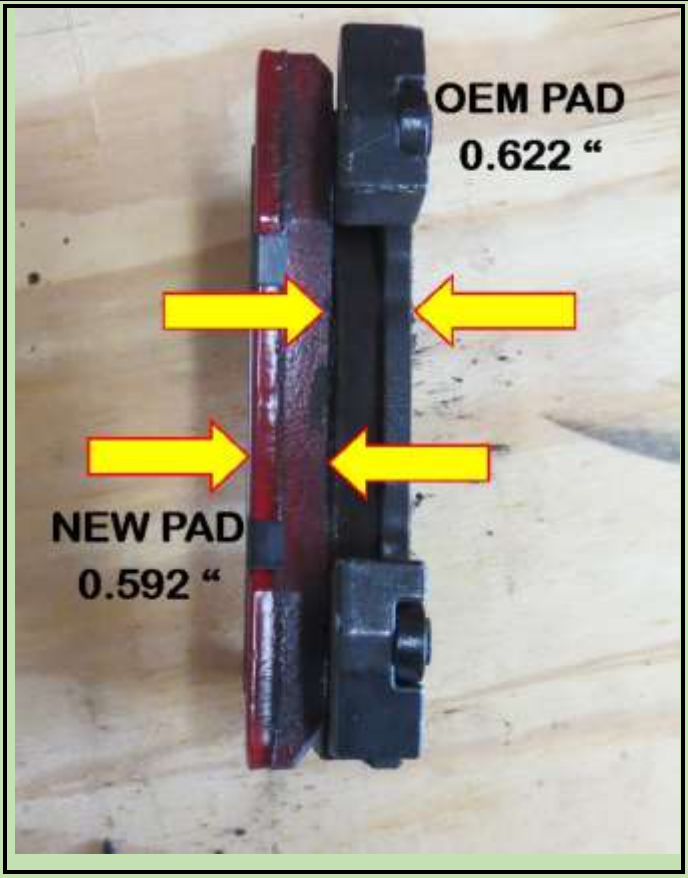
Tried a forum idea of making a thin knife by grinding a sharp edge on the back edge of a hacksaw blade. It was going very slow. Even tied the fine-toothed edge-no faster. May have worked but this approach was much quicker!

Used a stiff paint scraper and a hammer! Ground a sharp edge to one side, like a chisel. Inserted the flat side toward the back of the old pad and hit the top of the handle with a hammer. A few blows separated the sticky tape. It did take some significant force with the hammer.

Suggest getting a stiff scraper as short as possible. It may even be advisable to cut the handle down to gain room for a hammer blow. This was especially needed on the driver's side. I approached this piston-pad area from an angle on the driver's side rather than simply straight down as was possible on the passenger side. You can feel when it starts to separate. Some of the tape that stuck to the backing shim on the brake pad is seen in this pic.

Now I cleaned the empty cavity. Used the Brakleen on a rag, as someone on the forum suggested! Also sprayed it on a stiff bottle type brush used for cleaning wheels. To assure there was no damage to the paint, after using the rag and brush I quickly squirted alcohol over the whole area. This alcohol bottle came with a small flip lid cap and a small hole that when the bottle was squeezed created a fine stream. Bought a 2-quart package from Sam's Club for ~$4.

Using large quantiles of Dawn dish soapy water and alcohol were the most effective in getting most of the residual brake pad material cleaned.



Was planning to use the wide paint scrapper between the existing pads and the rotor, if needed, to push the pistons back. With two pistons, you must push both back at the same time or you'll push one out when the other is pushed in!

It was not an issue as the new pads were slightly thinner than the removed old pads! If needed there are special tools available if you're replacing well warn pads, google.

(A Forum Poster suggested two screw drivers could be used before the old pads were removed. They would be wedged between the pad and rotor to push the pistons back. If the pads were worn and thinner than the new pads, a good approach.)

These are the backs of the old pads and the pair of new Carbotech pads. Note the OEM pads have wear indicator springs on both front and rear pads (they make a noise if they hit the rotor.) The Carbotech pad only has them on one pad that I put on the front.

The OEM pad has added weights on the top of the pad. The way they are designed they look like a vibration damper (See Appendix, Tadge recently said they were just that!). They are apparently there to reduce vibration and noise. No such weights are on the Carbortech pads (although I believe they now use them for some models.). Both OEM and Carbotech front pads had shims on the back to reduce noise. The OEM's were attached with tape or glue and the Carbotech mechanically held on with clips.

What Brake Lub to Use?

Found this Permatex product, available in various sizes. Here is a description:

"Permatex Ceramic Extreme Brake Parts Lubricant is a 100% synthetic lubricant containing ceramic solids for extreme performance under the most critical braking conditions. A purple, non-melting formula, this premium lubricant is Permatex's longest lasting, most temperature resistant way to silence brake noise such as squealing and chattering. Excellent for sliding surfaces operating in wet or dry conditions from -65 degrees Fahrenheit to 3000 degrees Fahrenheit. This product assures that critical brake parts remain lubricated throughout brake pad life. Resistant to corrosion and contaminants, it will not wash out."

Decided the Permatex was what I would use on the back of the pads but GM recommends their product be put only on the pad sides. Found it for a discounted $0.83 per package versus a list of $3.14. Bought one package but it was just barely enough for the front pads! Should have purchased four! Fortunately had a small tube of the same high temp moly lub product. I used it for the rear pads.

The Permatex Lub was probably needed even more on the rear Carbotech pads as they do not incorporate any anti-squeal shims. Could have used it on the sides but from the very thick consistency it appears ideal for the back.

Bought My Pads from:
Adam@Amp'dAutosport.com

You can email or visit Adam on his website or call; he gives a 5% discount to forum members.

Adam suggested using sand paper to remove some of the old pad material from the rotor. Others recommended a Scotch-Brite pad. Found this 60 grit Norton sanding pad. It worked fine and quickly. Followed the advice of moving it 90 degrees to the surface as shown. Made several passes after cleaning the surface with a rag sprayed with Brakleen followed quickly with alcohol.

Did not use a great deal of force so the 60-grit pad was just cleaning the surface rather than scoring the rotor. The pad did pick-up material as can be seen in this pic. Not sure how effective it was but the rotors looked clean when finished. Did the inside the same way, was only able to access in one area. Rotated the disk as I moved the pad perpendicular to the axial.

After jacking the rear, moved the liquid catch pad and the WeatherTech cover from our old SUV we recently traded and that catches air-conditioned condensate in the garage! Kept the tiled floor clean! Used the same soapy water and it was easy to quickly remove the two pins. Note to be able to turn the rotor get at all spots, front and back it needs to out of gear and the parking brake disengaged. Use tire stops front and rear on the front tires before jacking.

Unlike the front, there is no sticky tape holding the rear pads to the pistons. Protected the caliper with a rag and with a large screw driver wedged on the pad edge that loosened it sufficiently to have it pull straight out with little force.

On OEM Rear Pads, Both Have Backing and One Anti-Squeal Shim

Carbotech Pads Have No Anti-Squeal Shims Or Wear Indicator

Note the OEM pads have anti-squeal shim as did the front pads. There was also a wear indicator spring on the outside OEM pad.

The Carbotech rear pads had neither. Tried to remove the anti-squeal shim from the old pad but it was glued on very tightly. It bent while trying. Would not have used them but wanted to see how tightly they were attached.

The Permatex Brake Lub was put on the pad backs and GM type lub on the sides and after cleaning the caliper cavity, like the fronts, the pads and pins were simply inserted.

Bedding Fundamentals

Bed-in consists of heating a brake system to a temperature to allow the formation of a transfer layer. The brake system is then allowed to cool without coming to rest, resulting in an even transfer layer deposition around the rotor circumference. The procedure uses hard braking 4 to 6 times so rotor face is evenly covered with brake pad material.

Because the adherent temperature range for brake pads varies widely (typically 100°F-600°F for street pads and 600°F-1400°F for race pads), each bed-in needs to be application and pad specific.

The key to a successful bed-in is to bring the pads up to their adherent operating temperature in a controlled manner and keep them there long enough to start the pad material transfer process. Different brake system designs, pad types, and driving conditions require different procedures to successfully accomplish the bed-in.
Note: Adam recently said Carbotech found users were overheating the 1521 pads probably using race pad bedding procedures. See my comment right.

The only difficult part is finding a safe road to do it!

Info from Carbotech: *Proper Bedding Instructions for the Bobcat 1521's.*
Note Adam recently said Carbotech found users were overheating the 1521 pads when bedding, causing glazing! They now recommend not doing it. If you have a noise issue, I'd suggest you use this less aggressive procedure they had published previously for 1521 pads.

1. Brake from 60mph to 30mph (not 10 to 15 mph used for some race pads.)

2. Repeat step # 1, 5 to 6 times.

3. Let your brakes cool for about 2-3 minutes while driving.

4. Allow the brake pads and discs to cool down to ambient temperature (driving about 30 minutes without stopping).

NOTE: Proper bedding of pads & rotors will result in greater performance and longer pad & rotor wear.

I followed this older Carbotech procedure noted above. It is different than their other brake pads suggested for racing pads.

About the third hard 60 to 30 mph stop they pulled somewhat to the right, but that could have been the road contour. When finished all stops were smooth, straight and felt like the old OEM pads.

INSTALL GRAND SPORT POWER STOP Z26 PADS

Bought a few new items for the Grand Sport:

Reverse Logic Jack Pads- they can be temporarily bolted into the chassis if going to a dealer or tire store. Just unbolt the pieces, remove the white inert (pic right) and tighten bolt when in the shipping slots.

Also bought their Lug Bolt Guides. Great product, makes installing the wheels easier. Especially useful for the wide rear wheels,

Don't rely on a jack to hold the car. Use a jack stand. I often leave the jack in the lift position with moderate pressure in addition to the jack stand but never would remove the wheel and work on the car with just the jack.

Reverse Logic sells a very cleaver well-made wheel stud extensions called "Lug Guide" highly recommended for the wide Grand Sport Tires. Buy and use 3 there is a discount! Makes installing the wider wheels and tires much easier. They have an internal thread you just screw over the

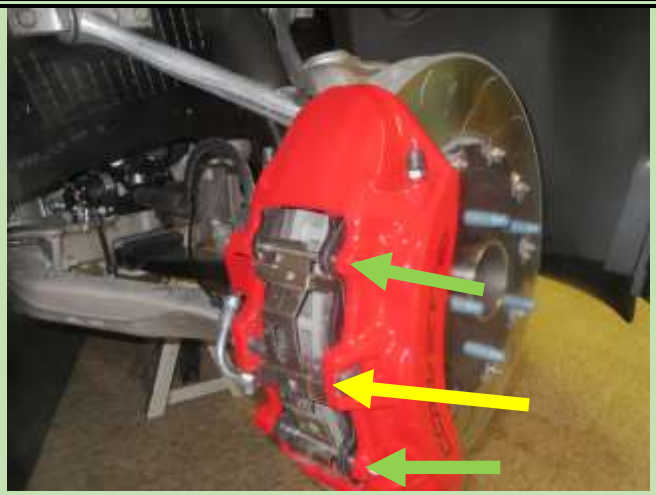
Definitely recommend their purchase.

With 37 miles on the car, just used alcohol on a rag to clean the rotors.

There is a center bolt in the three piston front calipers. Just use a ratchet and socket on the nut on the inside and remove it.

The pins that hold the retention spring are the same as those used for the Z51. Just use a 5/52 drift (or a 5/32 drill bit) and push out.

NOTE: See page 25 for tip on installing the pins to assure they are seated.



I marked on the spring retainer with a Sharpie to show the Top Outside so they went back the same as removed.

Used the OEM parts NOT those that came with the Power Stop Pads

The OEM and Z26 pads are identical in shape. The Z26 pads are slightly thinner so no need to press the pistons back to make room for the new pads. If replacing worn pads place a wedge between the pad and rotor and replace one pad at a time.

I used the small amount of lub supplied with the Z26 pads on the pad outer steel edges.

I put a thin layer of the Permatex Ceramic brake lub shown in the Z51 install on the backs of all pads as a help with noise.

BEDDING: After the install I bedded as Power Stop suggests. 5 moderate to aggressive stops from 40 to 10 mph followed by 5 moderate stops from 35 to 5 mph. Then drive for 5 to 10 minutes without stopping to let the pads and rotors cool.

Brakes stop fine and NO NOISE!

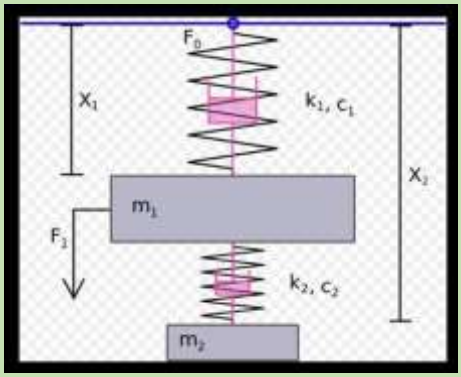
APPENDIX: The Z51 Pads: Mass Damper

The Carbotech 1521 nor Power Stop pads included the mass dampers that are on some of the OEM pads. However, my OEM Z51 pads that had them squealed like a "stuck pig" at low speeds before I bedded them! My Carbotech or Powerstop pads never made any noise. But I bedded both when installed.

In a December 2015 "Ask Tadge" Forum post he mentioned in a warranty subject for performance equipment being offered for the C7 that some items would have limited coverage and why.

For the kit to fit Z51 brakes on a base car he stated, *" the mass dampers were removed from the stock Z51 pads in order to fit inside of the base Stingray wheels. Mass dampers are used to tune the system for brake noise, and therefore this kit is not warranted for noise performance. The remainder of the factory warranty is intact."*

NOTE: Understand the Z51 Carbotech Pads now include the Mass Dampers, although I have not experienced any noise in almost two years of use without them!



The mass required for a specific application can be calculated. In some cases, a dual system with an additional damper is installed to stop vibration of the main mass damper!

I recall years ago using this approach to stop a copper water pipe from vibrating and making noise in our basement! It worked.

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Other practical applications of mass dampers include stopping wind caused vibrations in high tension power lines.

A unique application is this 776-ton mass damper that reduces the sway caused by earthquakes in a 101-story building in Taipei! It hangs from a steel structure that is tied to the building beams.

Role of Copper in Brake Pads

Rotor (Left) After a Year Using Powerstop Z26 Pads:

A forum poster installed Powerstop pads and operated for a year. He stated: *"Yes low dust and no noise but they turned my rotors brown."* He posted the picture left. He said it was not caused by rust etc. and I could only remove it with sandpaper. Someone suggested it was possibly caused by copper and another possibly iron being deposited from the pads material.

After 900 miles using Powerstop Z26 pads my rotors (right pic) are not discolored but there was tenacious brown material in the slots.

Friction Material in Brake Pads:

How the components in the friction material shear, break and interact during braking can determine a pad's friction level, noise and wear characteristics.

A brake pad may require up to 20 different raw materials. Some raw components are abrasive, while other components lubricate. Some components, like structural fibers and resins, hold the pad together, while other components tune the friction levels through various temperature ranges.

A friction material has many different components. Kevlar fibers, for example, help to give the brake pad structure under high temperatures. Copper is a durable metal that can dissipate heat quickly. That's the primary reason why flakes of copper have been mixed with other ingredients in many ceramic brake pads. The faster the pads dissipate heat, the cooler they run and the better they resist brake fade. That improves pedal feel, stopping distance and braking safety.

Typical Brake Pad Materials:

Non-metallic materials - these are made from a combination of various synthetic substances bonded into a composite, principally in the form of cellulose, and sintered glass. They are gentle on rotors, but produce a fair amount of dust, thus having a short service life.

Semi-metallic materials - synthetics mixed with varying proportions of flaked metals. These are harder than non-metallic pads, more fade-resistant and longer lasting, but at the cost of increased wear to the rotor/drum which then

must be replaced sooner. They also require more actuating force than non-metallic pads in order to generate braking torque.

Fully metallic materials - these pads are used only in racing vehicles, and are composed of sintered steel without any synthetic additives. They are very long-lasting, but require more force to slow a vehicle while wearing off the rotors faster. They also tend to be very loud.

Ceramic materials - Composed of clay and porcelain bonded to copper flakes and filaments, these are a good compromise between the durability of the metal pads, grip and fade resistance of the synthetic variety. Their principal drawback, however, is that unlike the previous three types, despite the presence of the copper (which has a high thermal conductivity), ceramic pads generally do not dissipate heat well, which can eventually cause the pads or other components of the braking system to warp. However, because the ceramic materials cause the braking sound to be elevated in frequency beyond that of human hearing, they are exceptionally quiet.

Types of Friction

There are two types of friction when it comes to brakes:

Abrasive friction is the wearing of the pad and rotor to change forward motion into heat. This type of friction involves the breaking of bonds of both the pad material and the disc's cast iron when the caliper pushes them together; however, both components experience wear. Semi-met pads and some non-asbestos organics (NAO) use this type of friction.

Adherent (or adhesive) pad material forms a very thin transfer layer of pad material on the surface of the rotor. The two surfaces are the same materials and generate friction by breaking or shearing the bonds in the pad.

Ceramic and some NAO pads use this type of friction. The transfer layer is bonded to the rotor's surface and cannot be washed away by water or wheel cleaners. The only way to remove it is with a brake lathe or abnormal heat.

The layer is always being worn and replenished by the brake pad during braking, so these pads produce dust. And, while adherent friction is easier on rotors, the pads become the primary wear component.

With this type of pad, it is critical to machine the rotor with the correct surface finish and follow the recommended break-in procedure so the transfer layer can be established.

With both types of friction, it is critical for the rotor to have minimal runout. Abrasive friction materials will wear away at high spots, creating disc thickness variation and pulsation. Adhesive (adherent) friction material could deposit the friction material unevenly and cause brake judder.

Bad Stuff

Why do some pads use components that could be considered harmful to the environment? Part of the answer is that some materials effect on the environment were not fully realized until a few decades ago.

Two states have legislation limiting its overall content in brake pad formulations.

The main focus of new laws in Washington state and California revolves around protecting the environment. Studies have shown 35 to 60% of the copper in water run-off is caused by brake dust! Much of the dust that is emitted into the air is blown onto areas next to the road, or is washed into the storm drains when it rains. Most storm drains flow directly into creeks, rivers and marine waters without wastewater treatment. Copper and other harmful materials can hurt and kill small marine animals and even render some fish without a sense of smell.

Marine Invertebrates

Invertebrates, which represent more than 95% of the known species on Earth, are animals without backbones. They are diverse, interesting, colorful, and unusual, marine life. In invertebrate marine life, copper alters their biochemical and biophysical properties even at very low concentrations. Water with even 0.018 ppm copper can be toxic to some invertebrates. In California and Washington, brake pads in 2025 must have less than 0.5% copper.

Benefits of Copper: **Despite its drawbacks, copper performs several functions: It adds structural integrity to the brake pad material, reduces fade so that brakes remain effective through extended braking events, transfers heat efficiently, and helps brakes be more effective in cold weather. Copper also has properties that help prevent brakes from squeaking and shuddering.**

Brake pad manufacturers are finding other materials to provide those braking properties. Some have already introduced "copper free" brake pads, including Bendix, Bosch and Hitachi who state: *"we have developed "copper free" brake pads with a stable friction coefficient by substitution of materials that perform the thermal conductivity and lubricating priorities with improvement in the change in friction surface.*

Experience With Iron Contamination

While managing in a welding materials R&D laboratory in Ohio I passed an open pit mine of a material we used in some of our welding fluxes. It was on the way to the Drag Races in Thompson Ohio, it was sand! The company we purchased from had various grades they sold at different prices. The highest grade was sold to folks making silicon commuter chips; it had very low iron content. Iron is a contaminant in the silica sand. In welding, it can influence the flux performance so we purchased a low residual content product that had low iron. We paid more than the "sand" they sold for concrete etc. that was a brown color.

When I passed this very large open pit mind you could see areas of pure white sand and the more common brown sand. We purchased product with a guaranteed maximum iron and other unwanted containments. As we did with all steel welding wire that came into the plant we checked the chemistry of the sand and other ingredients. That is the cost required to make a quality product. In fact, we were delivering some of these products to weld 10-inch-thick Nuclear power vessels and Nuclear submarines.

A quality product must start with quality, consistent materials. Could the brown rotor stain on Powerstop Z26 pads be caused by raw material contamination?

Data Supporting My (and Other) Findings: Inferior Cold Pad Performance with PowerStop Z26 Pads Versus Carbotech 1521

My comments about Carbotech 1521 ceramic pads versus Power Stop are strictly based on my experience! I have no affiliation with the company or Adam who is the Forum Advertiser that sells them!

Carbotech mostly make race pads and list over 60 brands of high performance cars, open wheel racers etc, including Ferrari, Porsche etc. They have 7 different compounds depending on the type of racing and one for Street use Carbotech 1521.

These are the details about each compound- note the operating range of each:

Carbotech™ 1521™
The Carbotech™ 1521™ is our high performance street compound. The 1521™ compound is known for its release and modulation, along with unmatched rotor friendliness. 1521™ is also a very low dusting and low noise compound with an excellent initial bite. This compound's excellent linear torque production provides incredible braking force without ABS intervention. Carbotech™ 1521™ operating range starts out at ambient and goes up to 800°F (426°C+). (I have seen 900 F also) 1521™ is suitable for ALL street cars, perfect for your tow vehicle or fleet vehicle. Carbotech™ 1521™ is NOT recommended for ANY track use.

Carbotech™ AX6™
The AX6™ is specifically engineered for Autocross applications. A high torque brake compound delivering reliable and consistent performance over a very wide operating temperature range of 50°F to 1000°F + (10°C to 537°C+). The advanced compound matrix provides an excellent initial bite, high coefficient of friction at lower temperatures along with very progressive brake modulation and release characteristics. Many drivers use the AX6™ for street driving as well, even though Carbotech™ doesn't recommend street driving with AX6™ due to possible elevated levels of dust and noise. AX6™ is NOT recommended as a racecompound in most applications.

Carbotech™ XP8™
A high torque brake compound with a wide operating temperature range of 200°F-1250°F+ (93°C to 676°C+). Carbotech™ XP8™ is the first of our racing compounds. Good initial bite at race temperatures, high coefficient of friction, excellent modulation and release characteristics. Extremely high fade resistance and very rotor friendly. Perfect for track day use with any tire and can still be driven safely to and from the track. Carbotech™ does NOT recommended XP8™ as a daily driven street pad due to elevated levels of dust and noise. Carbotech™ XP8™ is a great compound on the front & rear of most open wheel and sports racers.

Carbotech™ XP10™
When Carbotech™ unleashed the XP10™ to the general public it immediately gathered multiple regional, divisional, and national championships. The XP10™ has a very strong initial bite with a *coefficient* of friction and rotor friendliness unmatched in the industry. Fade resistance is in excess of 1475°F (801°C). XP10™ still maintains the highly praised release, excellent modulation and rotor friendliness that have made all Carbotech™ compounds so successful. Carbotech™ XP10™ is not recommended as a daily-driven street pad due to possible elevated levels of dust and noise.

Carbotech™ XP12™
Another highly successful XP™ series compound with an excellent initial bite, torque and fade resistance over and above the XP10™ compound. XP12™ has temperature range of 250°F to 1850°F+ (121°C to 1010°C+). The XP12™ has that excellent Carbotech™ release and modulation that has made all other Carbotech™ compounds so successful. The XP12™ is more rotor aggressive than XP10™, but compared to the competition the XP12™ is still very rotor friendly. XP12™ is NOT recommended for use as a daily driven street pad due to possible elevated levels of dust and noise.

Carbotech™ XP20™
The latest iteration of the highly successful XP™ series of compounds. XP20™ is a step up from the highly successful XP16™ compound. With an extremely aggressive initial bite, linear torque curve and excellent fade resistance the XP20™ is another major step in progression of the highly successful XP™ series line of compounds from Carbotech™. XP20™ has a temperature range of 275°F to 2000°F+ (135°C to 1093°C+). Carbotech™ XP20™ maintains our tradition of having the outstanding release and modulation that has made all other Carbotech™ compounds so successful. Carbotech™ XP20™ is NOT recommended for use as a daily driven street pad due to possible elevated levels of dust and noise.

Carbotech™ XP24™
XP24™ is the pinnacle compound of the extremely successful XP™ Series of compounds engineered by Carbotech™. This compound is based on the same fundamentals that exist in all other Carbotech™ formulations. XP24™ has even more initial bite, more overall bite, and more torque along with the most linear torque curve we have ever offered. The thermal characteristics are of the highest Carbotech™ offers along with one of the highest coefficient of friction ratings offered by anyone in the braking industry. This compound is the longest wearing compound Carbotech™ offers as it was originally engineered for endurance applications at the highest pro racing levels. This revolutionary new compound has been extremely successful with open wheel, closed wheel, sprint and endurance applications. XP24™ has a temperature range of 400°F to 2000°F+ (204°C to 1093°C+). Carbotech™ XP24™ is NOT recommended for use as a daily driven street pad due to possible elevated levels of dust and noise along with the necessary heat required to work properly.

Carbotech™ RP2™
The RP2™ compound was engineered for endurance racing based on our highly successful XP™ Series formulations. RP2™ has strong initial bite, a little less modulation than our XP12™, but still maintains the rotor friendliness of our XP™ series compounds. RP2™ has great fade resistance with a temperature range of 250°F to 1450°F+ (121°C to 787°C). RP2™ is as rotor friendly as our XP™ series compounds. Carbotech™ RP2™ is NOT recommended for use as a daily driven street pad due to possible elevated levels of dust and noise.

PowerStop Z26: Company Description:

Power Stop extreme pads are made for high performance street drivers who demand shorter stops under the most demanding conditions. The Z26 brake torque is consistently higher than OE pads with outstanding thermal stability. Power Stop Extreme Performance pads are best suited for high horsepower cars and big wheel upgrades. The Z26 friction compound is a carbon fiber and ceramic hybrid that resists fade to 1500 degrees. With Z26 pads, you can count on superior pad bite without dusty wheels.

(My Note: PowerStop state the Z26 pads can operate up to 1500F BUT make no mention of the best lower operating temperature. Looking at the Carbotech performance operating ranges it appears obvious they need to be at least warm!)

In Addition to My Observations:

These two Corvette Forum posters said similar things to what I observed about PowerStop Z26 brake pads:

village idiot (a knowledgeable avid Tracker)
CF Senior Member 8/17/2018

I put the Power Stop Z26 pads in and I seriously regret it. Braking power and bite sucks compared to OEM. It was actually kind of dangerous- not because the braking system is inadequate but because I wasn't used to it. It was a big enough change from street to race pads for the track but this is going to make it far more pronounced. Not sure I'd do it again if I had the chance.

Z06NJ
CF Senior Member

Initially you will feel that you have to step harder to make them brake the same as OEM. That's because all you know up to that time are the OEM brakes. However, with time, it becomes like muscle memory. Now I just brake like normal and don't even think about it.

But I'll never forget the 1st day I got them installed and I was driving home, I was like "WTF's going on here...I'm gonna end up rear ending somebody" LOL
But you get used to them.

Others Than Wecker3 Posted About the "Brown Rotor" Color

KGrant CF Senior Member

OK I love my PowerStop pads and after 3k miles they stop fine and the decrease in dusting is great. However, I to have noticed the brown on the rotors and was wondering what is the deal on the brown and is there a remedy or cause of the browning?

Marcho Polo CF Senior Member (9/2/2018)

I had them on my Z51 and they certainly did discolor my rotors. And they didn't need to just be washed. Man people sure get pissy around here just because others have a different experience or opinion!
Other than turning my rotors brown, I think the PowerStops were just fine for street use. I do believe they had a little less bite than stock pads, but I got used to it. I put 15,000 miles on them and they absolutely had hardly any dust and I loved that.
To each their own, it doesn't piss me off if someone buys PowerStops! Who the F cares!?!?!?
I'm going with Carbotech this time on my GS. Doesn't mean I think anyone that uses PowerStop are a dumbass or anything.

Reinforcing A Carbotech 1521 Feature I Find Very Important; Very Linear Pedal Modulation: From Carbotech Website

Carbotech Performance Brakes™ began 26 years ago. Carbotech Performance Brakes™, the world leader in Ceramic friction materials™. It was over eight years ago that Carbotech started building brake pads out of Ceramic, Kevlar, and Carbon for street, autocross and racing applications. Carbotech is the only brake pad manufacturer in the world with a complete line of Ceramic compounds for street, autocross, and track use. Carbotech-Ceramic™ compounds are known for their unsurpassed release & modulation, while maintaining very consistent torque control characteristics.

Our competitor's brake pads perform like an "on/off" switch. Brake pads that perform like an "on/off" switch are upsetting the balance of the car by violently

throwing all that weight forward (not to mention that you don't get any modulation with an "on/off" type of brake pad). You don't realize how much it upsets your car until you have tried Carbotech Performance Brake pads. That's because you have the ability to modulate your pedal with our ceramic/Kevlar compounds. That's a huge advantage to any driver, especially a driver who has a good feel for their car. The more you can modulate your brakes the more car control you have under braking. The more control a driver has under braking gives the driver an edge in the braking zone and the first part of a corner. Control which in the end helps you attain faster and more consistent lap times. Go Deep™

Research & Development (R&D) is not just a company philosophy; it's a way of life for Carbotech. In fact, R&D at Carbotech is a 365 days a year job. Continuous improvement is a cornerstone in Carbotech's solid foundation we have built because great compounds are not engineered overnight. You'll find that no one else in the industry releases new compound formulations like Carbotech consistently does. We don't believe in finding a good compound and resting. We are constantly improving an already great compound while at the same time continuing R&D on new compounds. Continuous improvement, with no end in sight. We strive in constantly improving our existing compounds as new technologies and materials come to market. In fact, the 1521™ compound is arguably our most successful compound, and it continues to gain enormous popularity among the performance industry. But, we didn't rest on its success. We recently improved the 1521™ compound to be even quieter and smoother when applying and releasing the brake pedal while keeping its outstanding performance right on target.

Picture is Worth 1000 Words:

Pad Brand/ Model *	Min Temp	Max Temp	Max Temp Rotor Color
Carbotech 1521 (Street Pad)	50 F	900 F	Faint Red
Carbotech XP8 (Race Pad)	200 F	1250 F	Cherry Red
Carbotech RP2 (Race Pad)	250 F	1450 F	Bright Red
Carbotech XP21 (Race Pad	400 F	2000 F	Yellow
PowerStop Z26 (Street Pad)	NO DATA	1500 F	Bright Red

Data from Company Websites. PowerStop Low Temp can be inferred from Carbotech data

Poster asked for data on pad temp thinking it had to do with ambient temp!

Note: It's pad temp not ambient that matters for best stopping performance!

As with most things in life, brake pads are a compromise. Very high max temp performance means the low temp best performance is higher!

If rotors are Glowing Bright Red get racing pads, but warm them up to stop well.
If Glowing Yellow get high temp race pads and get them over 400F to stop well!

Installing Brake Pad Pins:

In September 2018 a poster asked how to get the brake pad pins "seated' in a Grand Sport or Z06 where plastic brake cooling ducts make it difficult to get a hammer with a drift behind the pins. He said he could get his flush in the rear but they needed to be recessed another 1/32 inch to be seated.

Of interest, another poster included a video of a brake pad install. It showed a small amount of pin protrusion on the outside of the caliper with the OEM pads and more with the same pins after the new pad install.

I recalled using a hammer and making them flush but did not recall recessing.

YouTube Video of PowerStop Pads showed and interesting Pin protrusion in the beginning of the video left and final install right.

Note the difference. In addition in the video the installer used a hammer to make the pin flush but in that view the pins DID NOT PROTRUDE.

Decided since it was time to rotate tires, so I would check my brake pad pins.

Found the pins only protruded in the front by about 0.02 inches. They were flush with the rear not recessed.

Cut a short ¾ inch long drift from the end of a drill bit with a Dremel tool.

Held it with a pointed nose small Vice Grip and struck with a ball peen hammer. 3 or 4 short blows were sufficient.

Found I could recess the back of the pin about 0.06 inches and they then protruded about 0.08 inches in the front.

Were they not holding prior? They were as the spring, roll pin type section that holds them in place was inside the hole in the caliper.

Is it better to have them fully seated? *SURE!*

Would the average mechanic bother to made and use a small punch to recess the pins? Doubt it! *But why not do it right!*

Note, the spring section is higher in the center of the lose ring, so it would provide the needed friction with minimum contact. Also, there no horizontal loads on the pin.