

## Introduction

I'm going to share a little secret with you: As delivered from the factory, the brakes on your car are not capable of handling repeated lapping on a racetrack. They're also probably not very good for Autocross, drifting, or rally racing. I don't care if your calipers are painted red or gold, if you have gigantic carbon ceramic rotors, or if your car is advertised as being optimized on the Nordschleife. Do you know why your brakes are not up to the task of a serious thrashing as delivered? It's the lowest common denominator rule.

In the US in particular, manufacturers try to make every car as accessible to as many people as possible. That includes the guy who probably has no business being behind the wheel. Despite the hardcore enthusiast's wishes, that's why you don't see fixed-back race buckets in a stock Corvette, and why stiff, manually adjustable coilovers aren't standard issue on a 911. It's much easier to push a button in the cockpit. The same is true of your car's brake system. If a manufacturer delivered a 'track-day special' with an extremely noisy brake pad, there would be countless complaints and warranty-related service calls. The Nissan GT-R is a perfect example. The owner's manual clearly states that the car has high-performance brakes, and that they could make some noise. I was browsing one of the GT-R forums the other day, and of course there were a number people complaining about brake noise. Go figure.

So, how do manufacturers address this problem? They compromise, sometimes heavily. *The fundamental dilemma of taking a street car on a racetrack is that it was designed to do so many other things besides going as fast as possible.* A purpose-built racecar has no such identity crisis. The brakes fitted to your car as standard are one of the most glaring examples of this dilemma, and they're often the first vehicle system to wilt when leaned upon under heavy use.

What we want and need from a street pad is completely different from what we expect out of a race pad. For day-to-day street driving, we'd all love to see our pads have the following attributes:

- Never make any noise
- No dust on our fancy wheels
- Good cold bite on the way to work
- Effective in the rain and snow
- Last 100,000+ miles
- Never wear out rotors

When the weekend rolls around however, our priorities shift. We want our pads to have the following traits:

- Enough heat capacity to never fade after repeated lapping on a racetrack
- Predictable torque response for precise brake pedal feel and modulation
- No required bed-in or preparation
- Low compressibility for a rock-hard brake pedal
- Immediate release from the discs when we let off of the brakes
- No uneven pad deposits or scoring of the rotors

- Little to no wear as heat increases

See any differences between those two lists?

Unfortunately, most manufacturers err on the side of caution, and prefer to make the stock brake pads as docile as possible for the street. They know that one day your girlfriend or wife will take your Evo to the store, and she'll tell you that there's something wrong with your "screechy brakes." For the hardcore enthusiast however, the inherent performance compromises in OE brake pads are difficult to accept.

Therefore, our currently available options are as follows:

1. Accept the sub-par performance of the factory pads during aggressive driving, and enjoy their docile manners around town
2. Try to find a 'happy medium' pad that contains some attributes of both street and race pads
3. Install a harsh race pad that performs well in motorsports but has no 'street-friendliness'

So, we have some choices to make. We must define the most important pad characteristics for the type of driving we'll be doing, and choose a pad strategy with acceptable compromises. We try to get as close to *our* happy medium as possible, based on how we use *our* car. Every situation is different.

## **Basic Pad Composition**

Before jumping into specific pad selection, let's first take a step back and look at the bigger picture. Understanding the material composition of the four basic pad types, and how those materials behave on our cars, will substantially narrow the sensible choices for any given driving condition.

Brake pads for street cars typically fall into one of four categories. These categories are defined by the pad's fundamental composition: organic, semi-metallic, ceramic, and sintered.

### **Organic**

Organic pads are made of fibers mixed with fillers and binding resins to hold them together. Some components commonly found in organic pad are glass, Kevlar, and carbon. Organic pads have what enthusiasts consider a 'mild' character. They tend to be softer, easier on rotors, and they don't make much noise. In the US, most OEM's ship organic pads in new cars because they don't require a lot of heat to generate friction, or bite. They are therefore safe for commuting in various environments. While these pads offer comfort, their Achilles Heel is a severely limited temperature range. Once they reach their maximum operating temperature, they almost immediately lose their coefficient of friction and burn up very quickly.

The materials used in these pads are the least costly to acquire, as are the tools and processes to manufacture them. Therefore, organic pads are typically the least expensive pad type.

## **Semi-metallic**

Not surprisingly, semi-metallic pads get their name from their composition. Each friction puck contains a substantial amount of metal. Common ingredients are steel wool, iron, or copper, mixed with fillers, friction modifiers, and lubricants such as graphite. On the plus side, these pads have higher operating temperatures than organic pads, draw heat out of the rotors, and do not wear as quickly. On the other hand, they're more abrasive and tend to wear rotors more quickly, make more noise, produce heavier dust, and many times have very little cold bite. Most race pads on the market today are semi-metallic.

Because the constituent materials, tools, and processes involved are more expensive than those used to produce organic pads, semi-metallic pads are more expensive.

## **Ceramic**

The term 'ceramic' has been a hot marketing buzzword in brake pads for the past decade. These pads are created by mixing ceramic fibers, fillers, and bonding agents. The greatest benefits of ceramic pads are their lack of dust and noise. They tend to wear a little longer than organic compounds, and are also a bit more rotor-friendly. While they may have a higher temperature threshold than some of the organic compounds, they cannot compete with semi-metallic or sintered pads for heavy duty use. Enthusiasts who spend a disproportionate amount of time staring lovingly at their 6" polished rim lips may enjoy ceramic pads. Those who prefer to actually drive their car hard may be disappointed with the performance of ceramic pads.

## **Sintered**

While sintered pads have been popular on motorcycles with steel rotors, they remain an emerging technology for automotive use. Most sintered pads are formed from a copper alloy powder. The powdered metal is mixed with other lubricating and wear controlling constituents such as graphite and carbon, formed into the required shape, and then brazed to a backing plate at temperatures as high as 1800 degrees F. ]

Sintered pads have some unique characteristics vs. other pad types. Their nearly pure metal content provides a stable coefficient of friction from cold to hot, meaning they often need almost no warm-up time to produce bite. Since they're formed at extremely high temps, they don't fade under extreme use. They also don't create as much of a transfer layer on rotors, and therefore don't require a lengthy, traditional bed-in procedure. Since the pads are semi-porous, they can be used in any weather condition: rain, snow, mud, etc.

Because they are mostly metal, the negatives traditionally associated with sintered pads have been increased rotor wear, noise, and the transmission of heat into the calipers.

The materials, tools, and processes involved with producing sintered pads are the most expensive of all current pad types.

The chart below provides a summary of expected pad characteristics based on the material composition. There are exceptions, but these are the general rules of thumb.

	<b>Organic</b>	<b>Semi-metallic</b>	<b>Ceramic</b>	<b>Sintered</b>
<b>Common Usage</b>	Street	Race/Track	Street	Race/Track
<b>Noise</b>	Low	Moderate to High	Low	Low to High
<b>Dust</b>	Varies	High	Low	Varies
<b>Judder</b>	Varies	Varies	Varies	Low
<b>Max operating temp.</b>	Low	High	Low	High
<b>Pad life</b>	Varies	Varies	Varies	Varies
<b>Rotor wear</b>	Low	High	Low	Varies
<b>Cold bite</b>	Moderate	Low	Low	High
<b>Judder/pad deposits</b>	Varies	Varies	Varies	Low
<b>Compressibility</b>	High	Low	Moderate	Low
<b>Cost</b>	Low	High	Moderate	High

## How Will You Drive Them?

Looking at the dissimilar ingredients in each pad type above, it should be obvious that they'll perform quite differently as driving conditions change. The underlying components dictate each pad's basic operating parameters. If you ran a piece of chalk down the side of your car, would you expect identical results when doing the same thing with your house key? Of course not. It's not any more reasonable to expect an organic pad to last forever at 1200 degrees F, or a semi-metallic pad to run silently against an iron rotor.

Each pad has its ideal operating conditions, which may or may not fit your driving style, habits, or requirements. So how do you choose the pad that's right for your situation? You compromise, beginning with your top priorities and working your way down to the traits that aren't as important to you.

Let's take a look back out our initial bulleted list of desirable characteristics for the street and track, except this time we're not going to isolate the street from the track. Instead, we'll blend the lists together into one abbreviated attribute list:

- No uneven pad deposits, judder, or vibration
- Low noise
- Low dust
- High max operating temperature (fade resistance)
- Good cold bite
- Long rotor life
- Effective in all weather conditions

- Good hot bite
- Long pad life
- Predictable brake torque response
- No bed-in
- Low compressibility
- Immediate release

Now we'll take a look at each of the scenarios you may encounter behind the wheel, and examine which characteristics are the most desirable or important for that type of driving. The goal of this article is not to dictate the perfect pad choice to you. The objective is to get you thinking about as many of the factors that go into pad selection as possible for your unique situation, which should help you make an informed purchase decision.

### **Daily driver shared vehicle**

If you share your street/track car with a significant other, save yourself some headaches and go with as mild of a pad as you can stomach. Unless you can find a quiet sintered pad, organic or ceramic pads are your only logical options. You'll have to accept the fact that your favorite toy has become a glorified taxi and shopping cart. For this situation, important attributes from our list above include:

1. **Good cold bite-** When you hit the first stoplight on the way to work in the morning, you want the car to actually stop. Standing on the brake pedal and praying is a terrible way to start the day, and it's even less fun for the person you just rear-ended.
2. **Effective in all weather conditions-** Assuming you don't live in Southern California, having a daily driver that can slog through rain, snow, and dirt without compromising performance is important.
3. **Low noise-** If the pads on your shared vehicle are noisy, you may be sleeping on the couch. When the average schmuck who knows nothing about cars hears your S2000's squealing brakes and asks, "What's wrong with your car," you find it amusing. When they ask your wife for the fifth time, she may lose her mind.

You could argue that long wear rates and predictable response are both important to economical street driving. For the most part however, appropriately handling the three issues above should keep all involved parties relatively safe and happy.

The pads required to accomplish these feats very closely resemble the OEM pads found in most US passenger cars. These are the issues on manufacturers' minds when they decide on a pad compound. They want to make the brake system as idiot-proof as possible, avoid all warranty claims for noise and vibration, and ensure that even the most careless won't hurt themselves while driving their mobile phone booths.

If you want to drive your shared car aggressively on country roads, canyons, or in any type of motorsport event, buy a nice jack, ramps, and some hand tools, because you're going to be frequently changing your pads to get the performance you're after. Using a pad geared towards

solving the most basic transportation needs doesn't exactly provide a broad performance envelope.

If you try to take this type of pad into an aggressive driving situation, you'll encounter pad fade, lack of bite, poor modulation, and accelerated pad wear as temperatures rise. You may even trash your rotors with uneven pad deposits.

If your significant other isn't too vain, you may want to talk her into an inexpensive beater for daily driving duties. For the price of a nice set of wheels, you can buy a car that gets solid gas mileage, provides reliable transportation for many miles, costs almost nothing to insure, and you won't even have to worry about door dings. Implement the beater lifestyle, and your newly converted track-only toy will thank you.

### **Daily driver & Aggressive Street Driving**

Many enthusiasts fall into this category. You drive your car on the street to work each day, to run errands, and out to dinner when you feel like stroking your ego a bit (although you rarely allow the valet to touch your car...and you watch him like a hawk when he does). You take every opportunity in the evenings and on weekends for a spirited drive off the beaten path. You'd like to get into motorsports, but you're either unsure how to do so, have a severely limited budget, or a complete lack of time.

When we throw aggressive driving into the mix, we have to deal with higher brake temperatures. While organic pads could be an option, semi-metallic or sintered pads are the smarter choice.

1. **Good cold bite-** Even though you use your car for 'fun' driving in addition to daily duties, your safety is the top priority. It's still critical that your brakes bite cold on the way to work each morning
2. **Effective in all weather conditions-** As with cold bite, you're again constrained by daily driving requirements. If you live in Phoenix, enjoy that 'dry' July heat, and don't worry about this issue. If you dwell where the sun doesn't shine...ahem, sintered pads could be your best choice.
3. **High max operating temperature-** If you ever hammer your brakes on country roads or canyons in your spare time, it's entirely possible to get pad fade (firm brake pedal, but the car doesn't stop). See point #4 below if you only plan to get your brakes really hot "once in a while."
4. **No pad deposits, judder, or vibration-** The propensity for uneven pad deposits, or what many people call "warped rotors," increases dramatically when you plan to drive your car hard at times, but err towards a milder pad compound for comfort. You think to yourself, "Well I'm only going to get them *really hot once in a while.*" Whether done once or twenty times, organic compounds tend to smear on the rotors when pushed towards their maximum operating temperature, sometimes causing irreparable damage to both the rotors and pads. Yes, you can ruin your rotors the first time this happens, a costly lapse in judgment. Don't be the guy who says he'll only try crack once. If you plan to bomb away on your pads once, you'll do it more than once. If you think you'll

ever push your pads to a temperature above the recommended range for a given compound (even once), go with a compound capable of handling those higher temperatures.

You'll now have to decide if it's worth the additional noise, dust, and possible loss of cold bite to step up to a semi-metallic pad. If you go with semi-metallic's, research their cold bite before purchasing. Or, if you can find a low noise sintered pad, that would be acceptable as well, particularly if pad deposits are a concern. If you stick with an organic compound for comfort reasons, you must be mindful of brake temps. Backing off before you actually experience substantial pad fade can mean the difference between a fun drive and ruining your pads and rotors. If you have the experience to read the signals of an impending problem, feel free to ignore this advice. Otherwise, suck it up and deal with a little noise and dust you big baby.

Please keep in mind that there's almost always more than one solution to the same problem. In the above scenario, rotors that flow more air or brake ducting could both potentially lower pad temps enough for the use of a milder compound. These solutions work towards the same objective of lower overall brake system temperatures. To minimize compromises, look for different routes to the same objective.

## **Weekend Warriors**

Most serious enthusiasts begin with aggressive street driving, but eventually make the leap to some form of motorsport on weekends. They do so when they either have enough money to continually replace consumables such as brakes and tires, or when they become frustrated with the limited driving experience public roads offer. Because of the prohibitively high costs of storing and transporting a dedicated track car, the majority continue to drive their 'fun' car on the streets. Although over time, the car gradually becomes a different creature, one that is less comfortable, louder, faster, and much happier on a track than on the street.

With some motorsport experience under your belt, you likely find yourself driving slower and more sanely on public roads. You realize that you'll never be able to replicate your track driving style without killing yourself or someone else. Driving fast on the road just doesn't do much for you anymore.

At this point, many enthusiasts adopt a multiple brake pad strategy, one for the street, and one or more pad compounds for various motorsport venues. The street pad choice is now geared mainly towards comfort, although some still enjoy a quick blast down a deserted road. Most of these customers know when to back off however, and can recognize when damage to their limited street setup is imminent.

Let's take a look at the various motorsport venues for which dual-use street and track cars are commonly used, and examine the brake pad requirements for each.

## **Drag Racing**

Unless your car is on the verge of needing a parachute at the end of a run, any decent aftermarket pad should be able to handle one substantial stop from a relatively high speed. That said, I'd place **good cold bite** as my highest priority, particularly if you're driving a sub 11 second car like Vinnie Diesel. That means organic or sintered pads are your best options. Waiting around for your pads to bite when doing 130mph+ at the end of the strip is a pucker-factor 13, so I'd steer clear of ceramic pads, and be sure the semi-metallic's you're considering have good cold bite.

## Autocross

Autocross presents a unique challenge for your car's brakes. Depending on the course layout, the amount of pad heat generated may not be any greater than driving through stop-and-go traffic. Many times you never get out of second gear, which means speeds are generally limited to 60mph or less (yes, I know your Viper does well over 60mph in second). Additionally, the flowing nature of a well-designed autocross course means that you don't scrub off a tremendous amount of speed entering each brake zone. More often than not, you're trail braking as you approach the apex of the corner, rather than standing on the brakes in a straight line. Therefore, precise control and feedback is what you're looking for in a pad:

1. **Good Cold Bite-** In autocross, you don't have many chances for the perfect run. Just as with tires, you need immediate response from your brakes when you approach the first turn on the course. If the pads need heat to bite, you'll push your way into the first turn, and stutter into turn six as the pad heat builds.
2. **Predictable brake torque response-** Ideally, your brakes will feel exactly the same on the first stop as they do on the sixth stop, allowing you to smoothly enter each corner under braking.
3. **Effective in all weather conditions-** Autocross season usually starts in March, and in many areas of the country it's not surprising to see a light snow or rain at the first few events. Having pads that work in these conditions certainly won't hurt your cause in the season point standings, and will certainly give you the drop on fair weather competitors.
4. **No Bed-in-** Properly bed-in pads and rotors add a substantial amount of control, which is critically important in Autocross. While driving your car around on the streets you're gradually wearing off your pads' bed-in transfer layer. A pad that doesn't require a complicated bed-in procedure could be a big time saver and give you a competitive edge.

Due to the nature of the braking events, we don't really see many heat-related brake problems at autocross. Therefore, fade and uneven pad deposition can be eliminated from our requirement list. If winning carries any weight with you, noise and wear should not be considerations. If you're worried about dust on your wheels, wait until you try getting all of the tiny shoe polish bits out of the corners of your windows. Magnetic numbers are your friend.

Organic or ceramic pads could offer the desired results at Autocross, but may not have enough response or feel to satisfy the discerning driver. Additionally, most of these pads require a thorough bed-in and constant maintenance of the transfer layer to operate at their peak level. If you can find a semi-metallic with good cold bite, you'll probably be happier. Even better, a good sintered pad could address all of the critical requirements for a solid Autocross pad.

As mentioned earlier, you should explore various solutions when setting up your brakes for autocross. With some organizations, slotted or drilled rotors may not bump you to a different class, but they can add additional pad bite and control when trail braking. Stainless steel brake lines could also give you improved pedal response and feel. Reduce compromises by exploring multiple solutions to the problem at hand.

## **Gymkhana**

Gymkhana is a timed event on a closed course, which most Americans immediately liken to autocross. Similar to autocross, speeds tend to be lower in Gymkhana, with a focus on car control and precision. Some would argue that gymkhana events are even more technical however, as they demand the mastery of a different set of car control skills such as drifting, spins, etc. As we saw with drifting, the popularity of US Gymkhana is being fed from Japan, where it has been popular and competitive for many years.

Brake requirements for Gymkhana closely mimic Autocross needs, with cold bite and predictable all-season response emerging as the most important requirements. A semi-metallic pad with good cold bite, or a sintered material would be the best pad options.

## **Drift**

In the past few years a number of big brake kit manufacturers have targeted the drift crowd for advertising. Let's clear something up. The notion that fifteen inch rotors and twelve piston calipers will improve your drifting is just plain foolish. Big brakes are required when the primary objective is reducing brake system temperatures. Adding a gigantic brake kit to a drift-specific car is akin to perpetually having an import model riding shotgun. Your car will always look better, but you'll be continually dragging around dead weight and spending more money than you should. Tsuchiya-san would surely smack you with his finger pointer if given the opportunity.

Many of the techniques used to initiate a drift have little to do with the brake pedal. As such, brakes play a supporting role, rather than a starring role in drifting (with the exception of the hand brake). Controlling your car's weight transfer is crucial for effective drifting. As such, control is a higher priority than heat capacity.

1. **Good Cold Bite-** As with autocross and gymkhana, you don't have many chances for the perfect run in competitive drifting, and you don't have all day to wait for your brakes to warm up. The goal is to shift weight quickly and smoothly, and a pad that bites hard cold is a boon.
2. **Predictable brake torque response-** As with road racing, repeatability is critical in drifting. If the car enters a drift the same way every time, your ability to get creative increases dramatically. You know what the car will do in response to your inputs. You want your brakes to feel exactly the same at all times when making attitude adjustments to the car with the brake pedal.
3. **No Bed-in-** Properly bed-in pads and rotors add a substantial amount of control, which is paramount in drifting. While driving your car on the street with cold brakes, you're

continually wearing off the pad transfer layer on the rotors. A pad that doesn't require a complicated bed-in procedure saves time and provides a competitive advantage.

Although you'll likely give your brakes more of a workout in drifting than you would in autocross, you don't need the pad with the absolute highest maximum operating temperature on the market. Then again, you also don't want something that wilts as soon as the heat gets ratcheted up. If you go with a mild organic pad, you do run the risk of fade and uneven pad deposition. Wear isn't really a consideration unless you have a BBK, in which case new pads and rotors may cost more than the replacement value of your 240. If the dust on your Volks bothers you that much, use more Zaino you pansy.

Organic or ceramic pads probably don't have enough feel to satisfy the driver with a sensitive foot. Additionally, most of these pads require a thorough bed-in and constant maintenance of the transfer layer to perform optimally. A semi-metallic or sintered pad with good cold bite would be the ideal choice.

As mentioned earlier, you could evaluate slotted, drilled, or dimpled rotors to gain some additional pad bite and control. Some people like the feel of these rotors, while others find the grittier feel through the pedal distracting. Stainless steel brake lines offer improved feel, and don't forget to regularly flush your brake fluid to maintain the most solid pedal. Brake fluid constantly absorbs water over time, even under ambient conditions.

## **Show**

I threw this one in under motorsports for all of my show car friends, because I didn't want them to feel slighted. Seriously though, you really want my advice on which brake pads to use for your show car? How about the ones with the chrome backing plates and Hello Kitty stickers? Don't just sit there looking at it, play with it! Friends don't let friends have cars that are all show and no go.

## **HPDE (High Performance Drivers Education)**

Unless you flagrantly risk your life at every turn, you'll never put the same amount of heat into your brake system on the street as you will on a road course. HPDE is really the first venue I've mentioned thus far where maximum operating temperature and fade resistance come to the forefront as the critical brake pad requirements.

One of the most interesting aspects of HPDE is the wide range of speeds and driver ability across run groups. As such, it's difficult to recommend a blanket pad compound or type for HPDE. After countless discussions with customers on this topic over the years, I believe there are a few key considerations when selecting a track pad: Driver experience, track layout, vehicle configuration/modification, and tire choice. A careful examination of these factors in your personal situation should lead you towards an acceptable pad choice. Keep in mind that all of these factors are related, and cannot be considered in isolation from one another.

### ***Driver experience***

If you've never driven anywhere but the street, your first couple of trips to the track will most likely not tax your brake system too heavily, right? Not exactly. If you're driving a twin turbo Viper on R compound tires at Road America, you're going to have some serious problems with a bone stock brake setup. A blind chimp could obliterate the brakes under those circumstances, so you being a complete track newbie won't necessarily protect your brakes from destruction.

It's true that novice drivers tend to be easier on the brakes because their corner exit speeds are lower, their terminal speeds entering brake zones are therefore lower, and there's less kinetic energy being transferred into heat during a given stop. That said, novice track drivers also tend to stab wildly at the brakes, stay on the brakes too long, oscillate between on and off brake, and do all sorts of other things you never seem to expect from the passenger seat! The end result can be some serious brake punishment. It's impossible to say that a novice driver will be fine on stock brake pads based on track experience alone.

### ***Track layout***

Long straights followed by tight turns mean your car is decelerating from a very high speed to a very low speed, creating a high energy stop.

The distance between stops will also impact the heat retained in your brakes. If a particular track layout has a steady succession of medium straights and tight turns, your brakes don't have much time to cool between stops. That means heat will continually build. Flowing tracks with long sweepers are much easier on brakes (think Willow Springs).

Look closely at the track you'll be driving to determine how demanding it will be on your pads.

### ***Vehicle configuration/modification***

Power to weight ratio, drivetrain layout, and other brake system components all factor into pad selection for track duty. All else held equal, more massive, faster cars place a greater strain on the brake system in a brake zone. An Audi Allroad will require a much larger rotor as a heat sink than a Miata.

If you strip 200lbs. out of your car, you're placing less demand on your pads in terms of mass, but you'll be hitting higher speeds entering turns. For a given amount of power, lighter cars are easier to accelerate, and will reach a higher speed at the end of a straight.

Front engine cars are much harder on front brakes than they are on the rears. If you drive a 911 or NSX, your car uses comparatively more rear brake than a Viper, which has a massive V10 sitting over the front wheels.

If your car has large rotors and fixed (non-slider) calipers from the factory, is fairly lightweight with lower power (think DC5 Integra Type R), your pads will be much less stressed than on a heavy, powerful car with undersized factory brakes (base model 350Z).

The interplay of vehicle power, mass, weight distribution and the overall brake package will all substantially impact pad choice.

### ***Tire choice***

Tire choice is one of the single greatest factors in determining which pad will work for you on the track. The stickier the tire, the more brake you can use, and the more heat you will generate. More grip = more heat. If you're running street tires, or if it rains at an event, you won't be able to generate as much grip, and you won't tax your brakes as much. Maybe you really don't have to pull off your wheels to swap pads in that downpour!

So where does all of that leave us when choosing a pad for HPDE? The critical point is, every modification you make to your car and the nut behind the wheel will change the demands on your brake system, and you must adjust accordingly. Just because you used a particular pad before, doesn't mean it will work again after you've installed your new turbo kit and Hoosiers. Chances are that after your 25<sup>th</sup> event, you'll be taxing your brakes very differently than you did during your first event. You'll be hitting higher speeds, entering and exiting corners faster and in a different way, and your car will likely have more grip and power than it did when you started (you'll also be much poorer). As such, you must constantly evaluate the overall condition of your brake system, and not be afraid to try new pad compounds as both you and your car evolve.

**If you want to play it safe and not risk damage to the major components of your brake system, don't EVER drive an OEM pad on a road course.** It may be more convenient and seem economical to run stock pads, but it *will* cost you time and money in the long run. There's also not much worse than wasted track time. When you're sitting in the pits watching your buddy rip down the front straight, and your stock pads are a steaming pile of dust lying inside your wheels, you'll be wishing you took the hour on Friday night to change your pads and bleed your fluid. I can assure you that they weren't designed to cope with the stress of an HPDE event.

So, what pad attributes are critical for HPDE?

1. **High max operating temperature-** Pussyfooting around a track while nursing fading brake pads is incredibly frustrating, but slamming into a barrier after your brake pads have completely lost all grip on the rotors is slightly more upsetting. Evaluate the parameters of your situation as described above, and make sure you have pads that will handle the heat you plan to throw at them.
2. **No uneven pad deposits, judder, or vibration-** Although some pads may have problems in this area at moderate temperatures, this attribute often goes hand-in-hand with a High max operating temperature. You do not want a pad that readily smears high spots of material onto your rotors. Entering every turn with a thump-thump-thump through the brake pedal and steering wheel is extremely distracting, and could waste your hard-earned track time, your rotors, and a sizeable stack of cash.
3. **Predictable brake torque response-** If you want to increase your driving skill and graduate to the next level, consistency will take you there. Brake pads that feel the same

in every brake zone will go a long way towards improving your lap times and comfort on the track, as your mind will be freed up to focus on other things.

Although not critical, these are some other important attributes for HPDE:

1. **Good hot bite-** To a large extent, this is a matter of personal preference. Most pads with an adequate Max Operating Temp for the track have at least decent bite. That said, the coefficient of friction of race pads is all over the map. I'll discuss this topic a bit more in the next section, but most HPDE drivers enjoy a pad that requires only a modest pedal effort to produce tangible results.
2. **Long pad life/Long rotor life-** Your budget will completely dictate the importance of this issue, but the bulk of my customers don't have \$500 to burn up during every 20 minute track session. You'll have to find a pad that offers a balance of wear along with the characteristics you're after. A milder pad may be gentler on your rotors, but will burn up more quickly as the temps increase. A pad with ultra high bite may feel great, but it may chew your rotors up quickly. Tradeoffs, tradeoffs.

Good cold bite isn't really a huge issue in HPDE. Your warm-up /recon lap under yellow flag conditions is the perfect time to bring your pads up to temp, and in HPDE you're not running for a time on lap number two.

While driving on the track in the cold, rain, and snow is definitely entertaining, it's not the norm with HPDE's. Most sanctioning bodies delay or postpone events for adverse track conditions, so all-weather effectiveness isn't typically a prerequisite for a great HPDE pad.

When preparing your car for the track, you must take the time to bed-in your pads. Assuming you've accepted this fact, a pad that requires little or no bed-in would not be a critical performance advantage. It would however be a tremendous convenience.

Low compressibility and immediate release are nice-to-have's, but probably outside the scope of many HPDE drivers' concerns.

If you're worried about noise and dust while tracking your car, maybe you should just stick with knitting or coin collecting Sally. You're probably the same guy that uses two full rolls of painter's tape on your front bumper.

Semi-metallic and Sintered pads are the only reasonable choices for track duty. Organic and ceramic pads will rapidly turn to dust or melt, trash your rotors, and waste valuable track time.

### **Time Trial / Time Attack**

If you're competitively driving your car against the clock on a road course, you hopefully have a fairly solid handle on the capabilities of both yourself and your car. As such, your priorities for brake pads may shift above and beyond the critical necessities described in the HPDE section. At this stage you begin to evaluate the nuances of a pad compound.

I briefly touched on the generic topic of a pad's 'hot bite' in the last section. For the seasoned driver, *how* the pad bites when hot is a very personal and important attribute. Some pads have a completely flat torque curve: as temperatures rise, the pad's coefficient of friction remains constant and stable. During a stop, you feel this through the pedal. As you progress through a given braking event, you progressively push the brake pedal harder to slow the car "more." For many people, it's the only logical and ideal response out of a pad. They find it easier to adjust the car's cornering attitude by modulating the brakes with a linear leg effort...pushing harder means "go slower" or "stop!"

Others prefer a pad with a rising torque curve. As heat progressively builds during a stop, the pad's coefficient of friction ramps up as well. This type of pad requires a more constant, or even diminished, leg effort as you progress into a turn. The pads bite harder without much change to the force input.

The most obvious way to evaluate these characteristics prior to purchase is via a compound's brake dyno plot. Unfortunately, most manufacturers don't publish this data. Additionally, the methods used to collect and display dyno data is non-standardized. Therefore, the customer is presented with the classic dyno dilemma as witnessed in countless message forum wars regarding engine power. Brake pad dyno plots from different manufacturers should not be compared directly. Instead, they should only be used to provide general guidance on the shape of the Mu curve for a given pad compound, or to compare compounds within a particular manufacturer's available range.

In addition to Mu, advanced drivers take notice of other pad characteristics such as compressibility. Given the vast array of materials used to create brake pads, it isn't at all surprising that certain pad materials are more pliable, malleable, and compressible than others. If the primary components of organic compound A are newt eye and bat wing, it's going to feel a little more 'squishy' under foot than pad B made from nearly pure iron. Again, this is a matter of personal taste. Some drivers spit venom if they feel even the slightest bit of slack through the brake pedal. As with Mu, there's no easy way to identify a compressible pad prior to purchase. You'll have to rely on personal experience or the experience of others for guidance. (Note: If you bleed your aftermarket big brake kit six times and something still doesn't feel sharp when braking hard on the track, don't overlook a compressible pad material as a potential culprit.)

As with Mu and compressibility, release is a term you hear thrown around quite a bit in race pad discussions. A pad with poor release continues to ride the rotor after the brake pedal is released. The pads feel 'sticky,' and won't let go of the rotors as you trail brake into a turn. As with compressibility, you'll have to discover which pad compound suits your taste in this regard through experience or recommendation from a trusted source.

For the competitive time trial or time attack driver, experience and a detailed analysis of the driving environment will be core determinants in choosing the appropriate pad compound. It's obvious that a semi-metallic or sintered compound with a high max operating temperature and predictable response is critical. After that, it gets tricky. Relying on the subjective opinion of friends, competitors, and experts to describe the subtle nuances of a given pad can be helpful, but

don't be surprised if your reaction to the pads is completely different when you try them for the first time.

Because of their format, certain time trial and time attack events do offer the opportunity to exploit a competitive advantage through brake pad selection. Some organizations run a format of one warm-up lap, followed immediately by a very limited number of hot/timed laps (one to three), culminating with a cool-down. Just as with autocross, a brake pad that doesn't need a substantial amount of heat to provide stable maximum friction can provide a great advantage. In this regard, a sintered pad has the advantage over other pad types.

### **Wheel-to-wheel road course sprint & endurance racing**

Only a select group of individuals have the intestinal fortitude to rip a street car to pieces and turn it into a full-blown racecar. It takes some serious courage to weld in a cage and go speeding around a track six inches from a guy you've never met before. If you crash, you lose a lot of money. If you ever try to sell the car, you lose a lot of money. If you win, you lose a lot of money but you feel good about it.

Plenty of people in the PCA race their 911's and continue to drive them on the street. Most of these individuals simply leave their race pads in the car at all times, since the car is typically a weekend toy. On the rare occasion the car sees street action, they're happy to deal with the screeching, dusting, and complete lack of cold bite found in many semi-metallic race pads. In many of these situations, the car is even trailered to events, so there's not much concern about street manners.

The critical requirements for a good full race pad mimic those for time trials or time attack. The only notable exception would be the need for superior pad wear when endurance racing.

### **Rally /Hill climbs/Rallycross**

The variables and challenges in rally-related events are probably the most complex across all motorsports, and the drivers who excel in these venues are arguably the most versatile and talented. Most notably, track conditions in these events are much less controlled vs. other types of motorsports, and having a single solution for all occasions is virtually impossible. Drivers may encounter tarmac, dirt, mud, snow, ice, and water during these events. Each of these surface conditions prevents unique grip levels and brake requirements, and these surfaces are not always encountered in isolation from one another. For example, a car may encounter split-mu conditions, such as braking with the driver's side tires buried in loose gravel, while the passenger side tires are clawing for grip on ice. The ramifications of these complex conditions are outside the scope of this article, but there are some basic desirable traits for brake pads if you plan to take your STi, Evo, or 323 GTX to one of these events.

1. **Good Cold Bite-** You need pads with high bite on the first stop, and every stop thereafter. You may also have sizeable distances between heavy brake applications, which allow the pads to cool considerably. Good cold bite is a must for rally-type motorsports.

2. **Predictable brake torque response-** With ever-changing track conditions, you always want to know what the car will do in response to your inputs.
3. **Effective in all weather conditions-** A pad that can predictably perform when covered in water, snow, and mud is a huge advantage in rally events.
4. **No Bed-in-** Not having to bed-in pads or maintain a transfer layer is a tremendous advantage as event conditions change.

While this list mimics the requirements for autocross, the speeds associated with these types of events are normally higher. As such, ensuring that the pad you choose has a **High Max Operating Temperature** is also critical. Organic and ceramic pads are not really appropriate for these types of events. Some semi-metallic compounds may work well, but sintered pads will provide the most driver advantages due to their versatility during changing conditions.

It's extremely unfortunate that rally racing has never gained a sizeable mainstream acceptance or following in the US. Even during its Group B heyday of the early '80's, it never drew the audience that the juggernauts of F1 and NASCAR do today. Regardless of past public reception, if you've never watched Sebastian Loeb hit a jump, graze some crazy spectators, and narrowly dodge four trees larger than telephone poles all while sipping a latte, you really should. I still can't figure out how that guy fits his gigantic brass pair into a standard issue race bucket.

## **Overall most important vs. least important attributes**

So now that we've combed through most of the ways in which we'll potentially use our street/track car, which of the brake pad attributes from our list repeatedly came to the surface as being critical? The ones that allow us to go faster and enjoy our car more with less hassle of course!

- Good cold bite
- Predictable brake torque response
- No uneven pad deposits, judder, or vibration
- High max operating temperature (fade resistance)
- No bed-in
- Effective in all weather conditions

As a serious enthusiast, you're likely the competitive type who wants the best performance. Pads with the above performance attributes are not the cheapest to manufacture, are quite often specialized in their application, and probably aren't the best choice for your wife's car. If performance is your priority, you'll have to compromise on comfort and cost, which you'll notice rarely made it to the top of our priority list. These attributes are only important to manufacturers making a pad choice for the average Joe, and they likely hold little relevance to the type of driving you most enjoy:

- Low noise
- Low dust
- Long rotor life
- Long pad life

The grids below summarizes the important pad attributes by driving venue.

<b>Daily Driver</b>	<b>Canyons</b>	<b>Drag</b>	<b>AutoX/Gymkhana</b>	<b>Drift</b>
Good cold bite	Good cold bite	Good cold bite	Good cold bite	Good cold bite
All weather	All weather		Predictable response	Predictable response
Low noise	High MOT		All weather	No bed-in
	No Judder/deposits		No bed-in	
<b>HPDE</b>	<b>Time Attack</b>	<b>Wheel to wheel</b>	<b>Rally/Hill</b>	
High MOT	High MOT	High MOT	Good cold bite	
No Judder/deposits	Good cold bite	Good cold bite	Predictable response	
Predictable response	No Judder/deposits	No Judder/deposits	All weather	
Good hot bite	Predictable response	Predictable response	No bed-in	
	Good hot bite	Good hot bite		

If you try taking what appears to be the cheap and easy route of using OEM or low cost aftermarket pads for performance driving, don't expect a favorable experience. You'll have poor performance, and it will probably cost you more money and time in the long run than if you initially bought the proper tools to match your needs.

Ask yourself how much time you spend in each of the driving scenarios we examined. Do you use your car 98% of the time for daily driving, and only take the car to the track twice a year? In that case, it's probably worth the time to swap pads for the rare motorsport event. A good set of track pads is a great investment that will likely last you multiple years in this scenario.

On the other hand, if you're competing in autocross twice a month, time attack once a month, and canyon driving weekly, you'll either have to buy dedicated pads optimized for each driving environment, or you'll have to choose a pad that works fairly well for all of these scenarios. Just accept the fact that you will have to make some compromises in comfort, cost, convenience, or performance.

## **Closing comments**

Every time I see a lazy newb on a car forum toss out the innocent, "what's the best brake pad?" question without providing any information about how they actually plan to drive their car, I brace myself for the inevitable mind-numbing fanboy brand warfare that ensues. As you can hopefully see, there is no one best pad or brand for all people in all situations. Pads are largely a personal preference based on usage requirements.

While you should now be able to quickly assess a pad's basic performance envelope by knowing what it's made from, realize that there are exceptions. Don't be too hasty to immediately eliminate an option based on its composition alone, and please don't be afraid to experiment and try something different. That's why God created eBay and the message forum marketplace. What may not be ideal for your situation is probably perfect for someone else. I

feel bad for people who find something that always stick to what "works well enough." How do you know that something else won't suit you better?

Most serious enthusiasts have tried a wide range of compounds, and have developed at least some sense of what they do or don't like in a pad. This is where the real fun begins. Driving style and the appropriate product characteristics converge, allowing the driver to explore the car in new and different ways. At this stage you'll also be able to put into words more clearly what you're feeling with a given pad. Things like a rising torque curve or poor release will become more obvious with a broader base of comparison under your belt. While these terms will certainly confuse the hell out of your neighbor in a casual conversation, they will help you gain better advice and guidance from other drivers, racers, and industry professionals.

Take a serious look at your unique situation, assess your needs, and be prepared to compromise if you plan to use your car in more than one driving environment. The one-size-fits-all approach has never been a viable option in the brake pad market, nor will it be with the current technology in hand. Choosing 'the best' brake pad will be a unique process for every enthusiast based on their unique wants and needs.