



ECS
TUNING®

2-Piece Rotors

an **ECS Tuning**

white paper



2-Piece Rotors; Making an Informed Brake Parts Purchase

In the automotive specialty parts market where mass produced parts from unknown companies are sold side-by-side with quality offerings from reputable sources, how can an automotive enthusiast evaluate the potential value of a prospective purchase? This is especially difficult when comparing brake rotors.

To properly judge a brake rotor, a buyer needs to understand the purpose of the product, the selection of materials and procedures used in its manufacture, and the design features that make it desirable, durable, and effective.

Short product descriptions and ad copy are often insufficient for these purposes, since they gloss over or completely ignore product details.

In this white paper, we will discuss the reason for 2-Piece rotors, and explain the features and benefits of ECS Tuning 2-Piece rotors, in particular.

2-Piece Rotors - An ECS Tuning White Paper

Conventional Rotor Designs

Let's begin with a brief look at the function and design of a stock brake rotor. Cast iron is the brake rotor material of choice for original equipment manufacturers due to its low cost, durability, and large heat storage capacity. For daily drivers operated under average conditions, cast iron provides excellent wear and predictable braking.

Cast iron also stores and transfers heat well, naturally dampens vibration, and gets stronger as temperatures increase to 500-600 degrees F. It is strong under compression, and dimensionally stable at temperatures of 1000°F, or higher.

The downside of cast iron as a material for brake rotors? It's heavy. The mass of a solid cast iron rotor adds to unsprung vehicle weight, stressing suspension components, including bushings, ball joints, and dampers. Adding to unsprung weight also limits handling performance and tire adhesion (especially on uneven surfaces), and degrades ride quality.

A Compromise of Form and Function

To offset its weight, cast iron is commonly paired with lightweight aluminum in premium 2-piece rotors designed for competitive driving or for vehicle operation that demands sustained or forceful brake application, braking from high vehicle speeds, and greater than normal loading.

2-Piece rotors are also added as an appearance option since they are more attractive than stock cast rotors, especially when they are installed as part of a custom brake kit with painted components and custom wheels.

2-Piece rotor designs have a cast iron braking disc attached to an aluminum mounting hat by a ring of fasteners, either bolts or pins. Weight savings aside, aluminum dissipates heat faster than cast iron. In fact, the thermal transfer rate of aluminum is roughly 4 times that of cast iron. This configuration combines the natural advantages of a cast iron braking surface with the weight savings and rapid heat dissipation of an aluminum hat.

Due to the dissimilar expansion rates of the two materials, the hat and ring are allowed to "float" relative to one another to relieve stress and prevent component warpage.

While full-floating rotor designs allow for both axial and radial movement between hat and rotor, the added costs involved in producing them make their cost-to-benefit ratio impractical for anything but full-blown racing applications. Instead of being bolted together, the hat and rotor are commonly pinned together and float on pressure washers to provide movement in two directions.

A cost-sensitive but highly effective alternative used by the ECS Tuning 2-Piece rotor is a semi-floating design that allows radial movement, a solution that is suitable for street and many performance driving conditions. In fact, since the semi-floating design uses bolts instead of pins to attach the rotor hat and disc, they are generally preferred over full-floating designs for street use since they do not make annoying noises associated with many full-floating designs.

2-Piece Rotors - An ECS Tuning White Paper

Braking = Energy Conversion

Brakes slow a moving vehicle by converting its kinetic energy into heat energy. Heat generated by slowing the vehicle mass must be stored safely or dissipated quickly to prevent short term brake failure, or more serious damage that may extend beyond brake components to include driveline and suspension parts.

Excessive heat from rapid or prolonged brake application at high speeds and loads can also cause a phenomenon called fade. Fade is the result of brake pad gassing at high temperatures when resin vapors given off by the friction material create a compressible "cushion" between the pad and rotor braking surface. When fade occurs, the vehicle will not decelerate as expected during braking, and may fail to brake at all, even though pedal feel may be normal.

Extreme heat can also crack and warp rotor discs, or change spots on the rotor face into a hard, brittle material called cementite. These surface imperfections and metallurgical changes reduce braking efficiency, and lead to annoying brake judder and noise. Hard spots in the braking face require rotor replacement; resurfacing only masks the underlying metallurgical changes, whose troublesome symptoms reemerge quickly when the vehicle is driven again.

Stock vehicles driven "normally" are generally less apt to experience these problems, since intervals between brake applications are long enough to let the brakes cool. At lower brake duty cycles associated with average vehicle use, rotor mass sinks heat energy safely until it can dissipate. Brakes have a chance to cool before being applied again.

However, when a vehicle engages in competitive driving, experiences sustained braking on steep downhill grades, or hauls abnormally heavy loads, stock cast rotors can experience thermal overload and fail to brake the vehicle adequately. That's where design enhancements and the rapid heat transfer of an aluminum hat help a cast rotor disc dissipate its thermal load faster.

ECS Tuning 2-Piece Rotors

To provide better-than-stock braking performance under demanding conditions, ECS Tuning designed their 2-Piece rotors to combine proven features, quality materials, and close-tolerance precision manufacturing procedures performed by an ISO 9001 certified facility.

To produce this cost-effective, quality braking solution, ECS concentrated on the following critical concerns:

Design: ECS Tuning 2-Piece rotors have a semi-floating design that allows radial movement between hat and disc to compensate for their dissimilar rates of expansion. The hat and disc are connected by a ring of corrosion-resistant 12.9 hardness bolts.

2-Piece Rotors - An ECS Tuning White Paper

Directional Vanes: Directional vanes between the braking faces circulate air to remove heat by convection. The arced shape of the vanes improves air flows that cool the brakes faster, a premium feature that is more effective than straight-vaned rotor designs.

Drilling and Slotting: Disc faces are drilled and slotted to improve cooling and keep the brake contact surface clean. Slots are cut with a ball end mill to reduce edge stress and cracking. The slots evacuate brake dust and water, and scrape the pad face to prevent glazing. Cross-drilled holes promote additional air flows, and all are chamfered to reduce the formation of stress risers and radial fissures.

Hats: Rotor hats are machined from billet T6-6061 aluminum (tensile strength of at least 42,000 psi). To enhance its natural toughness, the finished aluminum hat is hard anodized for durability, good looks, and corrosion resistance.

Rings: Rotor rings are made from FC-30 cast iron, with carbon content as high as 3.3 percent, heat treated to relieve stress. Rotor faces are friction ground to ensure that inner and outer braking surfaces are flat and parallel, and promote even transfer of friction material during the bedding process. Rotor discs are machine-balanced, and non-braking surfaces are powdercoated to resist corrosion.

Quality Control and Testing

ECS Tuning 2-Piece rotors have been tested in thousands of miles of street and track driving, in all kinds of weather. Exposed to severe racing conditions, ECS Tuning 2-Piece rotors have been subjected to repeated, high speed braking at sustained temperatures in excess of 1000 degrees F; temperatures so hot that friction pads reached the point of ignition. Invariably, they have performed to design expectations.

Conclusion:

Built to exacting standards by a trusted manufacturer with an impeccable record for quality and superior workmanship, ECS Tuning 2-Piece semi-floating rotors offer high value and long service life for both street- and track-driven cars.

With thousands of rotors sold over the last decade, ECS Tuning has the experience and technical expertise motorists expect from their brake parts supplier. Backed by their in-house engineering department and service support staff, ECS Tuning 2-Piece rotors are designed to provide dependable, superior performance, and a long, safe, service life.