Audi Technical Updates

Ceramic Brakes, 07/2011

Ceramic Brake System

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Introduction

Fibre composite materials found in brake systems

C/C: carbon-fibre reinforced carbon (used in motorsport)

C/SiC: carbon-fibre reinforced silicon carbide (used in Audi production vehicles)

- ***Benefits:***
  - Low component weight → reduction in unsprung rotating bodies
  - High degree of temperature resistance → smaller decrease in the friction factor between the brake disc and brake pad at rising temperatures (brake fade)
  - High degree of wear resistance → approx. four times longer service life
  - Considerably better resistance to quick changes in temperature → virtually no geometric deformation of the brake discs when subjected to heat

Introduction
C/SiC – ceramic

Raw materials: combination of carbon fibres with phenolic resin and silicium granules

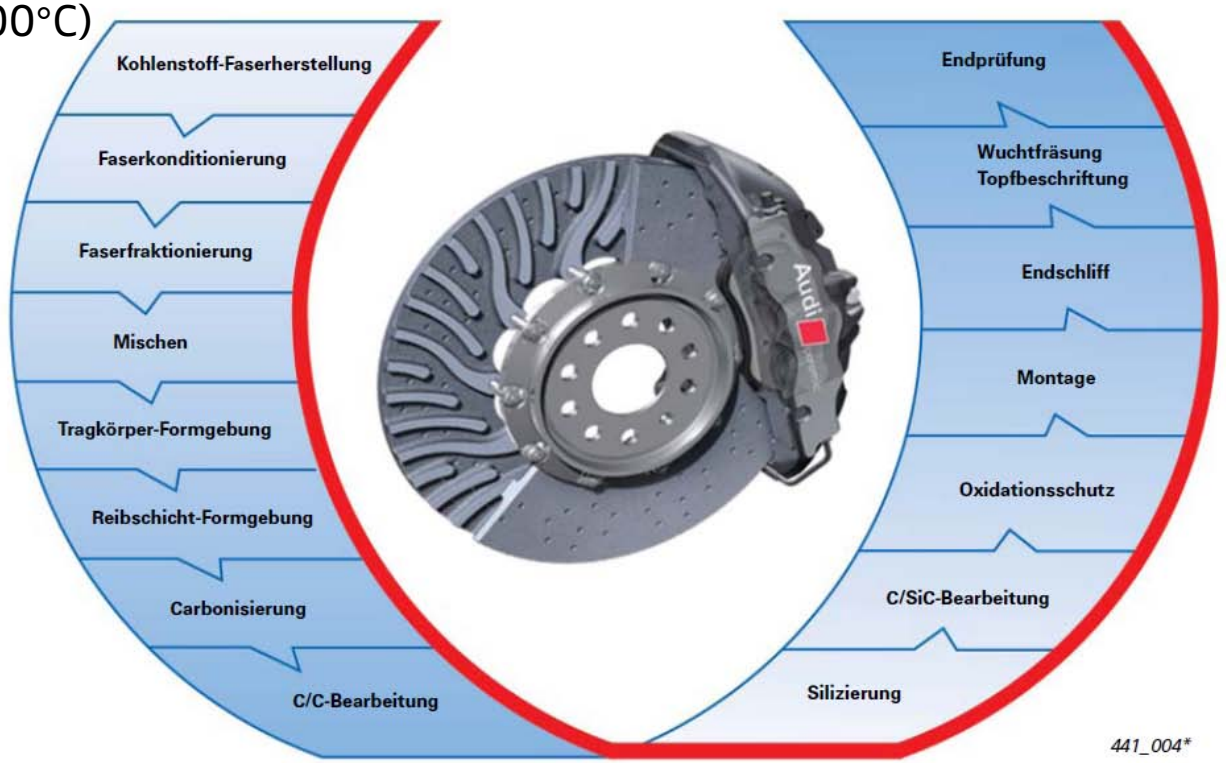
Silicium carbide: extremely hard → high level of wear resistance (similar to that of diamonds)

Carbon fibre: strengthens the silicium carbide matrix → enhanced fracture toughness

Introduction

Manufacturing a ceramic brake disc

- Complex manufacturing process
- Several manual process steps
- Time-consuming follow-up steps required on the unmachined brake discs, such as the final sanding stage
- High energy input required for the carbonisation and siliconisation processes (900°C/1500°C)



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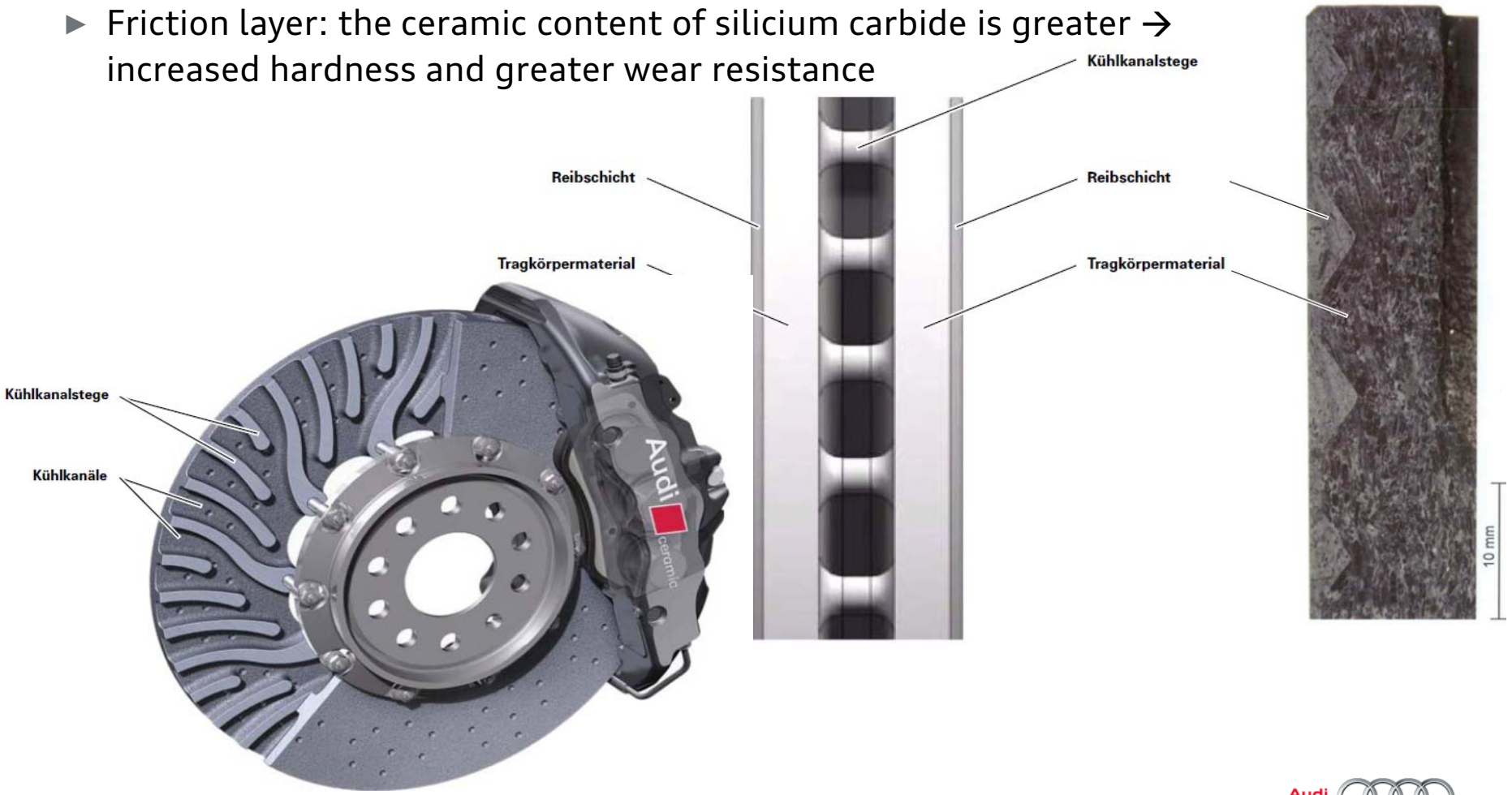
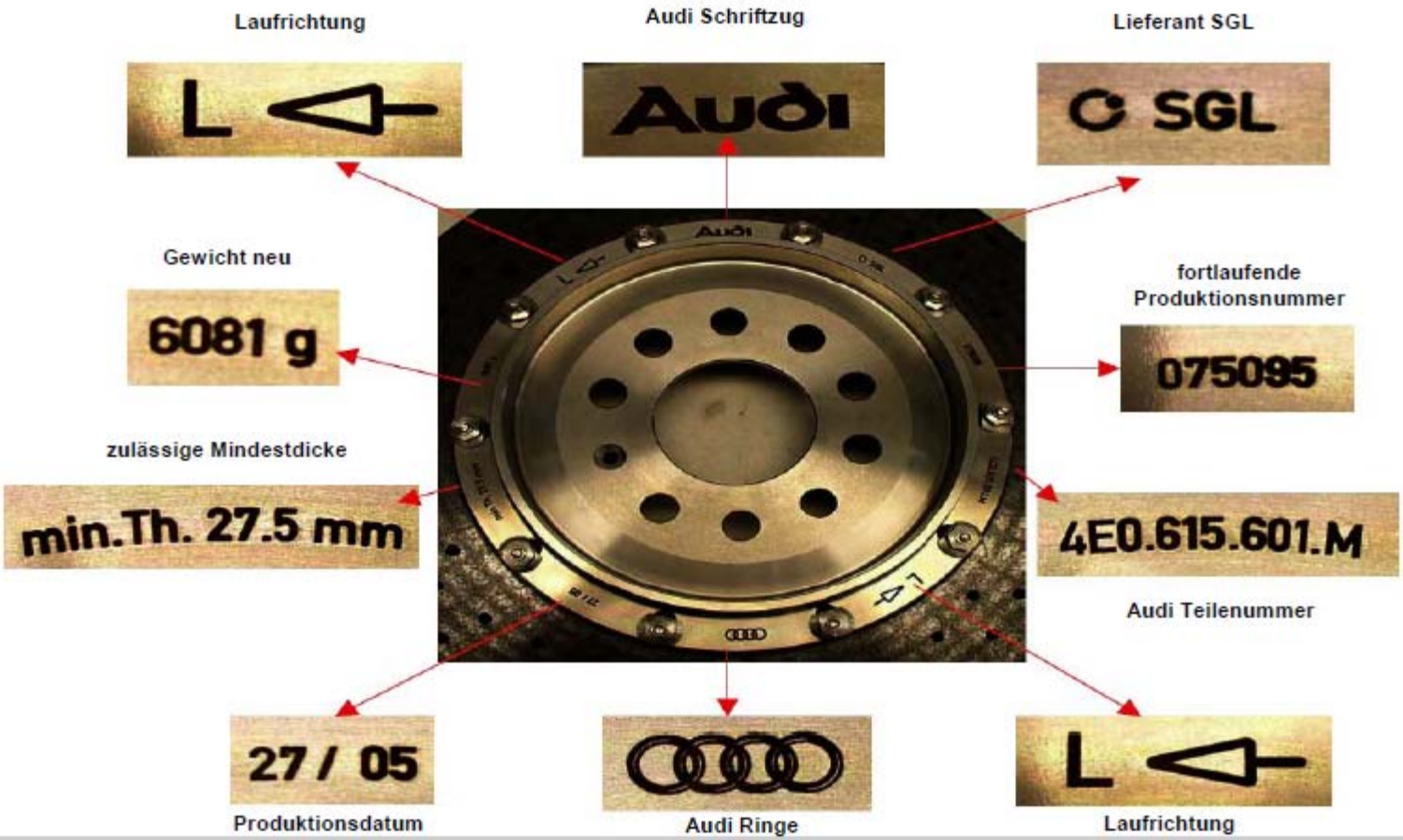
Composition of a ceramic brake disc
General information

- Material components
  - Supporting body: silicium carbide and free silicium
  - Friction layer: the ceramic content of silicium carbide is greater → increased hardness and greater wear resistance



Composition of a ceramic brake disc
Markings



Components found in a ceramic brake system

Brake pads for ceramic brake discs

- Organic brake pads (as used with steel brakes) have a higher content of non-ferrous metal to enable higher operating temperatures

- The service life of the pads is the same as that of conventional brake pads

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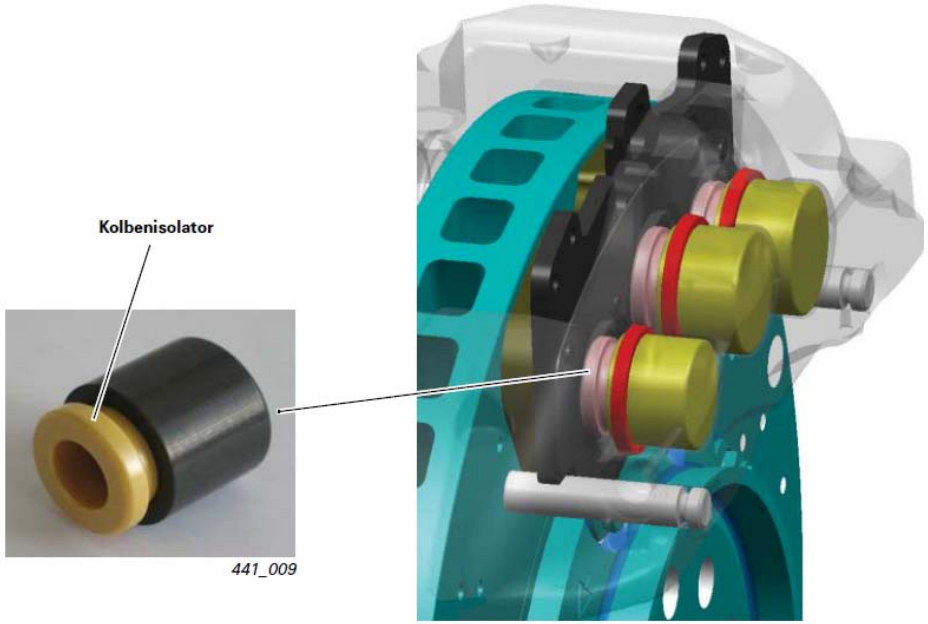
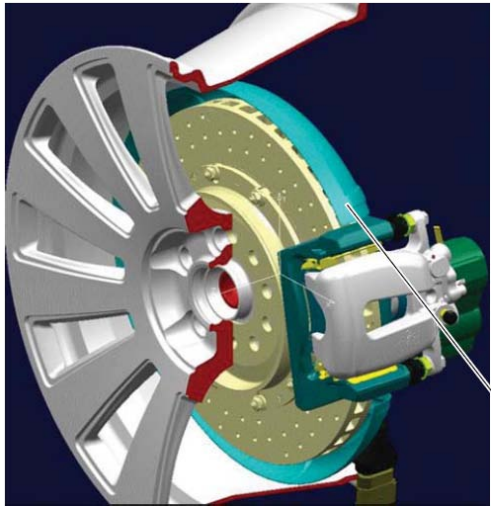
organische Bremsbeläge für die Keramikbremse

Components found in a ceramic brake system
Heat shield and brake caliper

- Brake caliper
  - High temperatures must not be transferred to the brake fluid
  - Special insulators are fitted between the brake piston and brake pad (zirconia ceramic)



- Heat shields

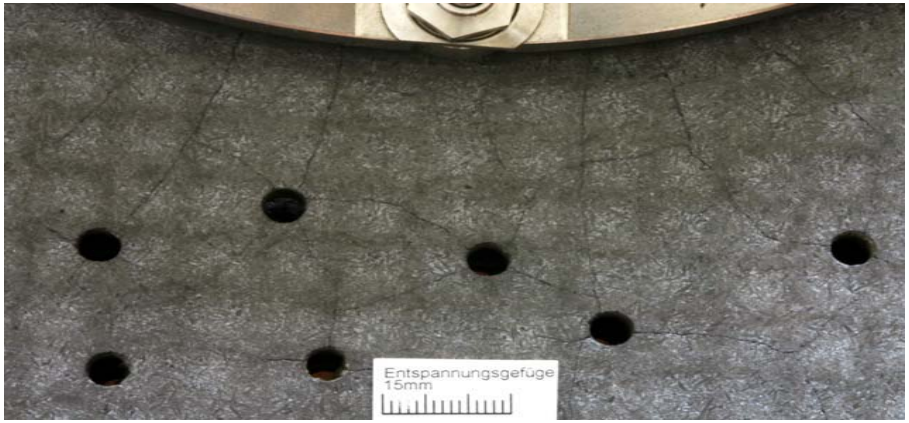


Visual features of a new ceramic brake disc

Any wear and damage must be assessed objectively in order to determine whether a brake disc needs to be replaced. For this reason, it is important to know how a new brake disc should look. The most important features are outlined below.

1. Stress relaxation cracking on the friction layers

When the disc is new, the friction surfaces are covered with varying stress relaxation cracking patterns. Some individual stress relaxation cracking runs alongside the perforation holes. The cracking pattern is sometimes easy to identify; it can vary considerably from one brake-disc chamber side to the other. Stress relaxation cracking occurs during the manufacturing process and is not a defect. The surfaces of the ceramic friction ring are very different to those of a conventional brake disc. A conventional brake disc featuring cracking of this type would need to be replaced, whereas it is a standard feature of ceramic brake discs. In some areas on the surface, the grooved texture of the transition area between the friction layer and the supporting body can be clearly identified in the form of a grid pattern.



Typical stress relaxation cracking and grid pattern found on a new ceramic brake disc

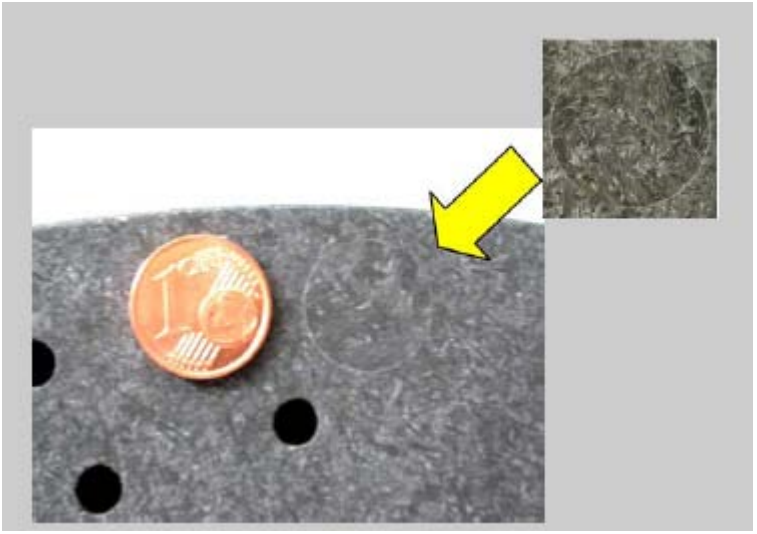
Visual features of a new ceramic brake disc

2. Wear indicators on the friction surfaces

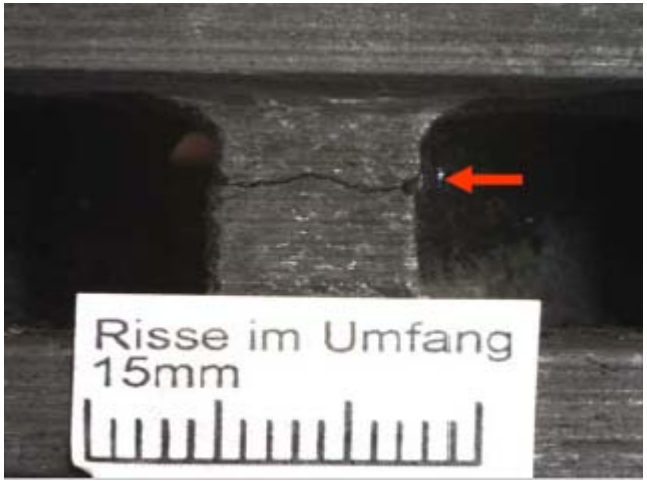
Three circular wear indicators can be found on every friction surface; these are distributed around the surface offset by 120°. These indicators are used to assess the wear of a ceramic brake disc following appropriately high mileage and/or appropriately heavy usage. The procedure for assessing wear indicators is discussed in the following chapter.

3. Surface cracks in the cooling duct bars.

Surface cracks in the cooling duct bars also a result of the manufacturing process and do not indicate a defect.

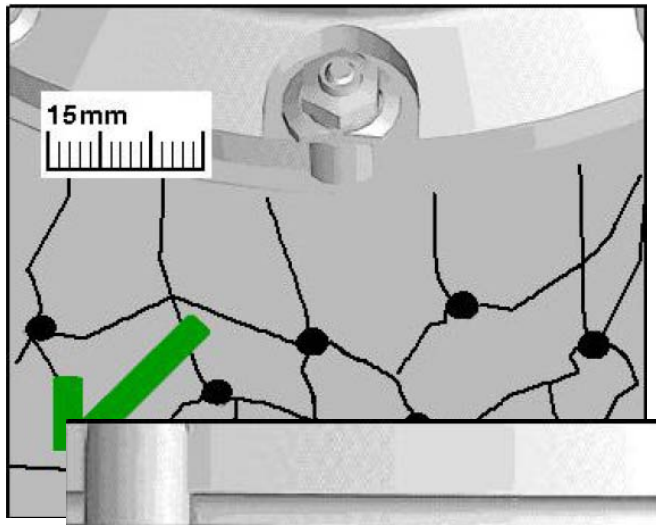


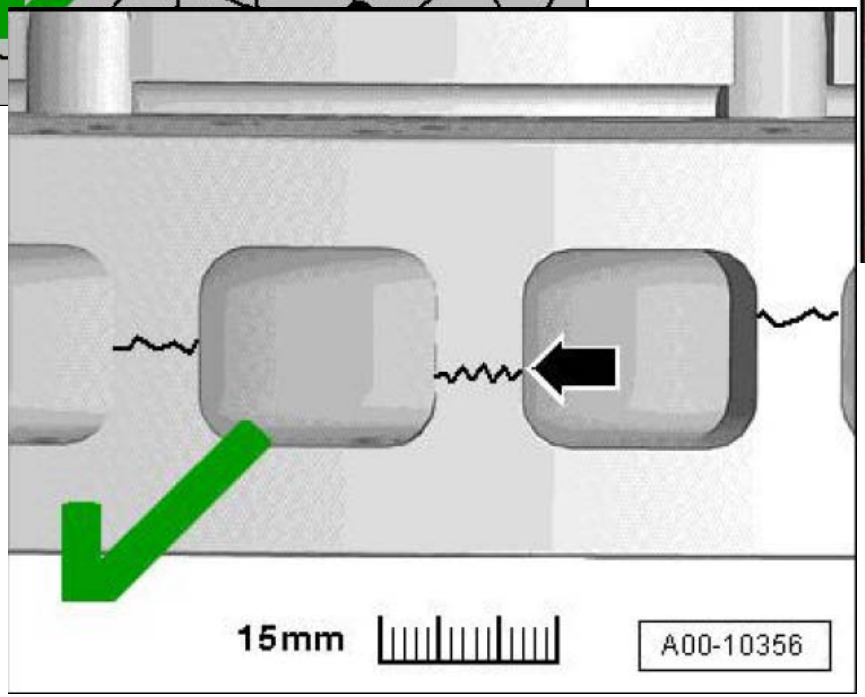
Wear indicators found on a new ceramic brake disc



Crack in a bar on a new ceramic brake disc

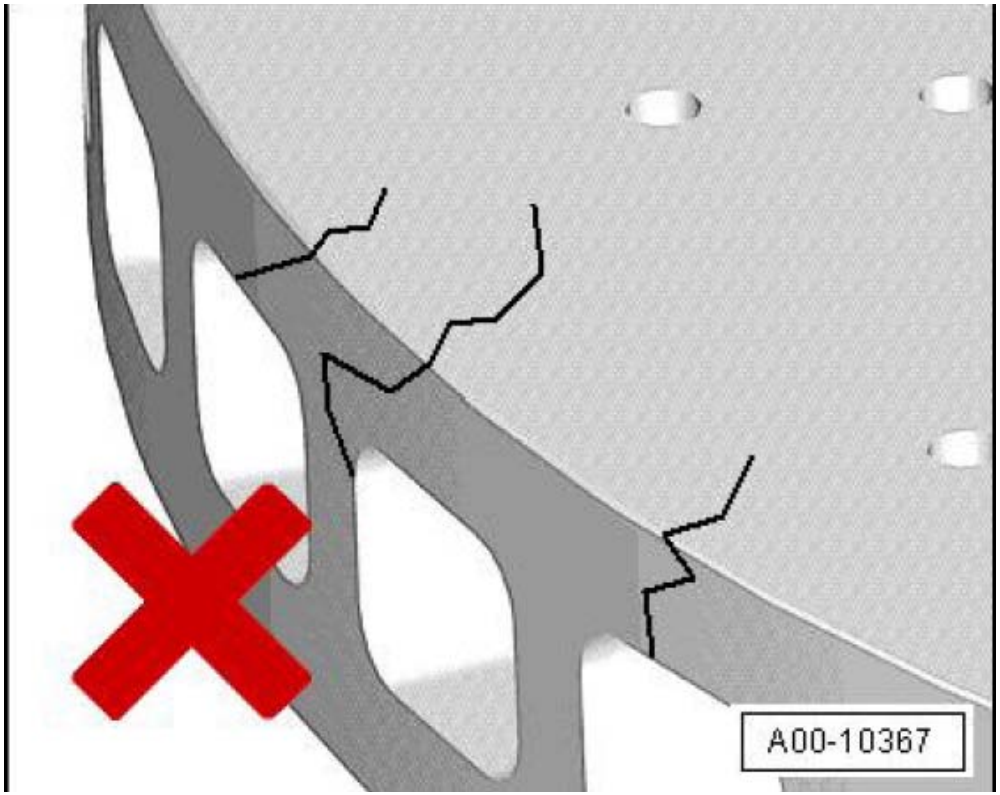
Visual features of a new ceramic brake disc





Beispiel Außenseite:

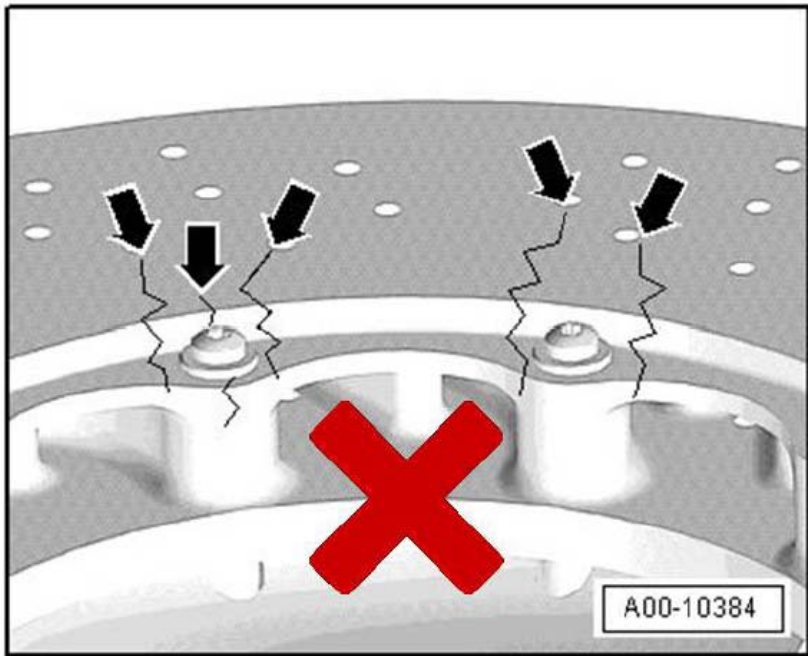
Damage



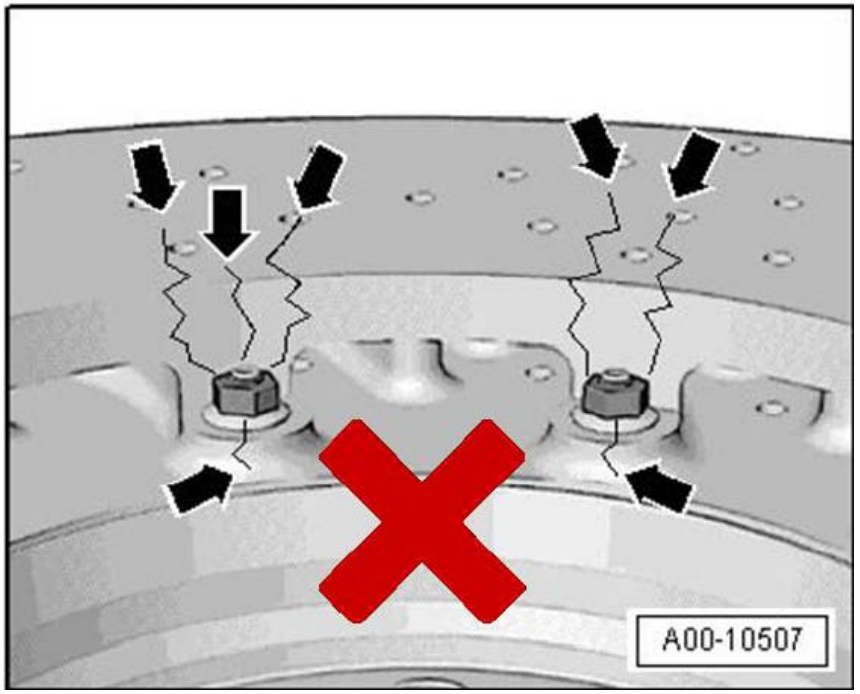
Falls Sie eines der nachfolgenden Merkmale bei der Prüfung feststellen, beachten Sie unbedingt die Meldepflicht vor Reparatur!

Damage

Innenseite A8, RS6 (HA) und RS4



Innenseite Q7, RS6 (VA) und R8



Falls Sie eines der nachfolgenden Merkmale bei der Prüfung feststellen, beachten Sie unbedingt die Meldepflicht vor Reparatur!

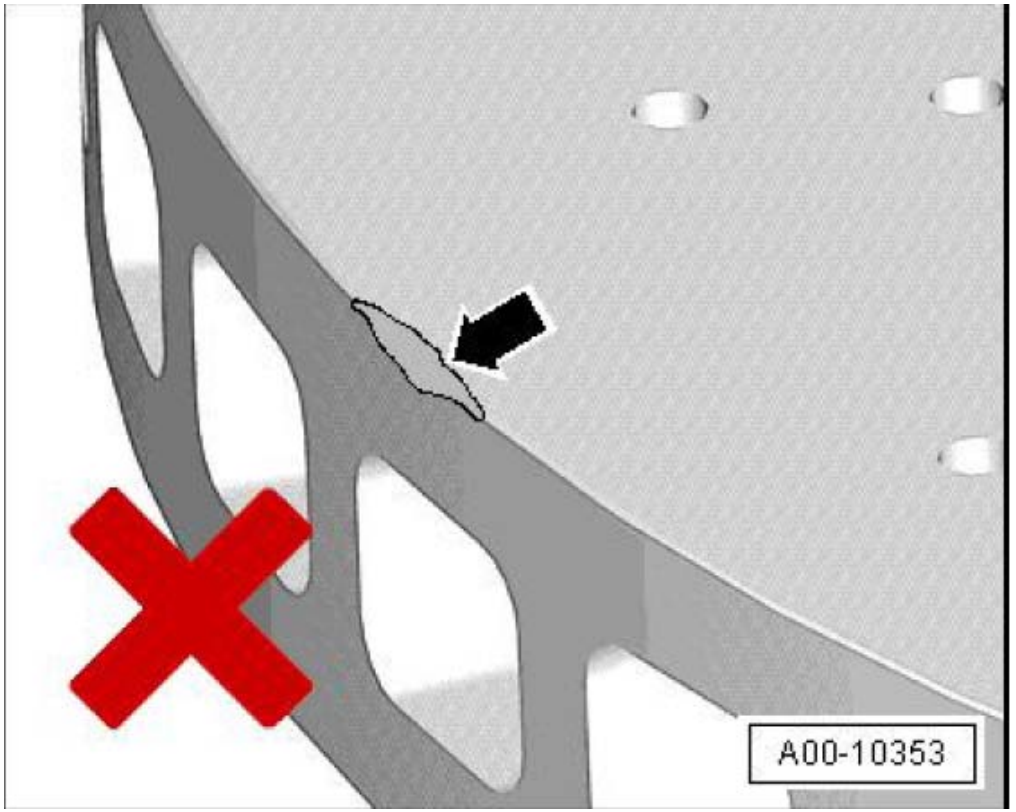
Damage

Kantenbrüche -Pfeil- entstehen durch mechanische Beschädigung im Kantenbereich.

Zulässig sind:

- max. Breite / Tiefe = 2mm
- max. Länge 10mm
- max. 3 Kantenbrüche pro Bremsscheibe

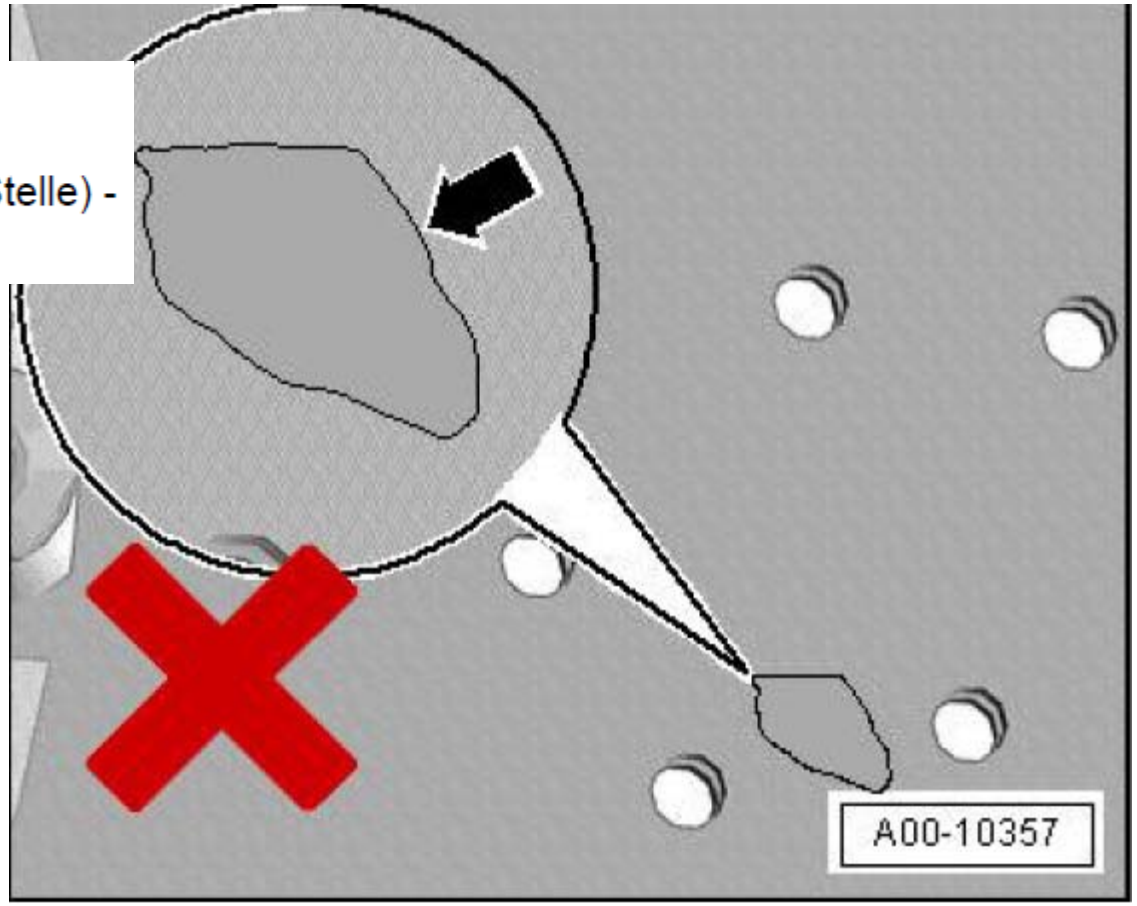
Bei Überschreitung der genannten Kriterien muss die Bremsscheibe ersetzt werden.



Falls Sie eines der nachfolgenden Merkmale bei der Prüfung feststellen, beachten Sie unbedingt die Meldepflicht vor Reparatur!

Damage

Keramikbremsscheiben mit Materialausbrüchen auf der Reibfläche größer 1 cm^2 (pro Stelle) - Pfeil - sind zu ersetzen.



Falls Sie eines der nachfolgenden Merkmale bei der Prüfung feststellen, beachten Sie unbedingt die Meldepflicht vor Reparatur!

Damage

Damage

A visual check for damage must also be carried out as part of routine inspections and in the event of complaints.

1. Cracks in the join area

As a rule, ceramic brake discs featuring cracks that run from the join area (area around the bolted connection to the pot) into the friction surfaces must be replaced!

2. Chips to the edge

Chips to the edge are caused by mechanical damage to the edge area.

Acceptable damage profiles:

- Max. permissible width/depth = 2 mm
- Max. permissible length = 10 mm
- Max. three edge chips per brake disc

If these criteria are exceeded, the brake disc must be replaced.

Abb. 20: kritischer Rissverlauf im Anbindungsbereich

Abb. 21: Kantenausbruch

Damage

3. Ausbrüche auf den Reibflächen

Bremsscheiben mit Materialausbrüchen auf den Reibflächen mit einer **Fläche von größer als 1 cm²** sind generell auszutauschen!

Abb. 22: Reibschichtausbruch

Note:

Brake discs are normally replaced at each axle.

It is therefore important to remember that the brake pads on each axle need to be replaced too.

Wear factors

As a rule, there are two types of wear that affect ceramic brake discs:

1. Wear in thickness

The mechanical friction between the brake pad and friction ring causes a reduction in the thickness of the brake disc. However, on account of the hardness of the friction ring surface, this wear in thickness is considerably less than that affecting conventional brake discs.

2. Assessing wear indicators

Assessing wear

The wear criteria displayed first essentially depend on the conditions under which the ceramic brake disc is used.

1. Measuring the wear in thickness

The permissible minimum friction ring thickness is engraved on the ceramic brake disc pot, indicated by the words **min. Th. (= minimum thickness)** (see figure 12). The brake disc thickness dimension **X must be measured using a suitable micrometer screw or a brake disc gauge** around the inner or outer friction surface tracks (see arrows in figure 18). The brake disc thickness must be measured each time the pads are changed and the measurements must be appropriately documented. When dimension X = min.Th. **+ 0.2 mm** is reached, the ceramic brake disc will always need to be weighed too (see point 3 for details on how to proceed).

Note:

Once the minimum thickness has been reached, the ceramic brake disc must be replaced.

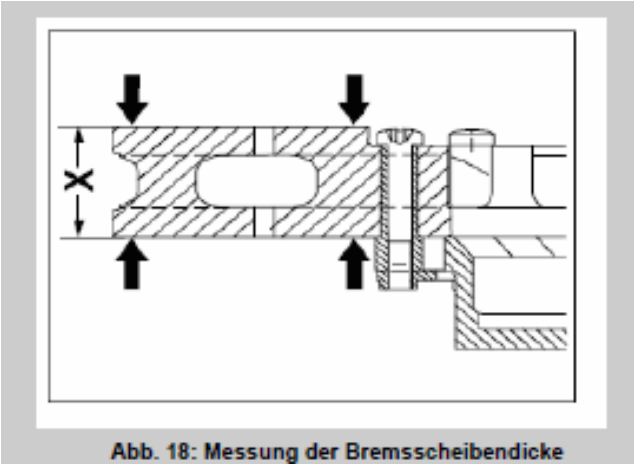


Abb. 18: Messung der Bremsscheibendicke

Assessing wear

2. Assessing wear indicators

Visually, the indicators can be identified by their slightly different color compared with the surrounding friction ring surface. This different color is caused by the higher carbon content, which, in turn, results in greater wear on these areas than on the surrounding friction surface.

Indicator wear is illustrated by material burn-off that can be recognized via dark-colored indentations. If the wear covers an area greater than 50% of the indicator surface, the brake disc thickness must be measured (see point 1 for details on how to proceed). The measurement must be taken as soon as one of the six indicators exhibits wear of this type.

Abb. 19: Beispiel für einen Verschleiß von mehr als 50% der Indikatorfläche

Correct procedures for working with ceramic brake discs in the service department

General process for working with ceramic break discs

- The following points must be observed when working with ceramic brake discs:

1. Avoid any mechanical impacts on the brake disc
2. Clean the brake discs using standard brake disc cleaning agents, steam cleaners or compressed air (caution: wear breathing apparatus when using compressed air!)
3. Defective or worn brake discs must be returned to Audi AG

Assembly mandrel in the vehicle tool kit

Process for changing wheels

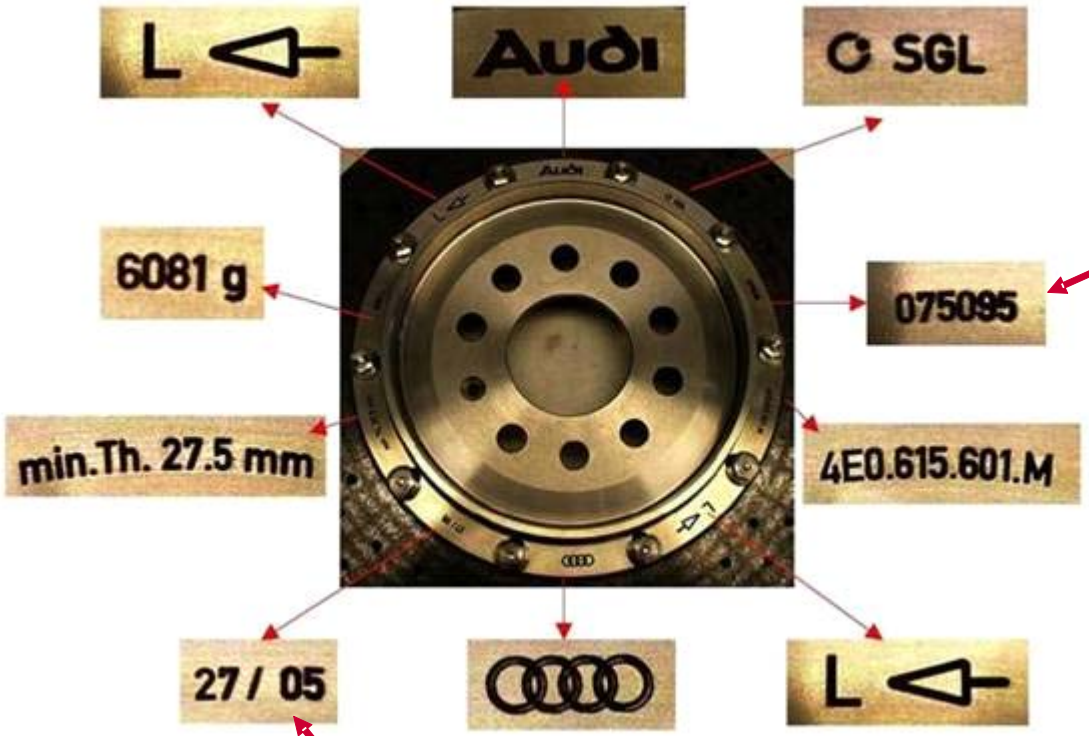
To stop the rim hitting the ceramic brake disc when removing the wheel from the vehicle, the vehicle tool kit contains an additional assembly aid. This aid comprises a mandrel that keeps the wheel away from the brake disc when removing it; this rules out any chance of the rim hitting the brake disc.

Note: It is essential that you refer to the Owner's Manual and Workshop Manual for the detailed process!

Assembly mandrel in-situ on a wheel

Service sheets

Ceramic brake disc serial number



Serial number	
FR:	
FL:	
RR:	
RL:	

Production date	
FR:	
FL:	
RR:	
RL:	

Braking behavior in wet conditions/brake disc wipe function

Braking behavior in wet conditions and with road salt

Brake disc wipe function

New:

From A8 D4 (including Q7 V12)

- Brake disc wipe function is activated if the rain sensor is switched to active (i.e. the intermittent wipe lever must be actuated)
- Brake disc wipe function is deactivated if the interval between wiper activations is longer than 30 seconds, even if the intermittent or rain sensor is active
- Speed at which it is switched on and off (vehicle speed) is the same at 80 km/h
- The wiping interval for GG brakes is every 3 km, and every 1 km for ceramic brakes (**i.e. not distance and time-dependent**)

Previously:

When driving in the rain or snow, the front brake pads are periodically (every 185 s) applied at minimum pressure (0.5–1.5 bar) to the brake discs for a short period (for approx. 2.5 s).

This process cleans the pads and discs; the responsiveness of the brakes is improved. This process is activated when the windscreen wipers are switched on and the vehicle is travelling at a speed of >70 km/h.

INCA test

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Thank you.