

GAMMATEC DENSITOMETER

The GAMMATEC Densitometer is a universal instrument for the determination of the density (specific weight) of metallic and ceramic powder compacts. The measurement is non-destructive, PC controlled and fully automatic.

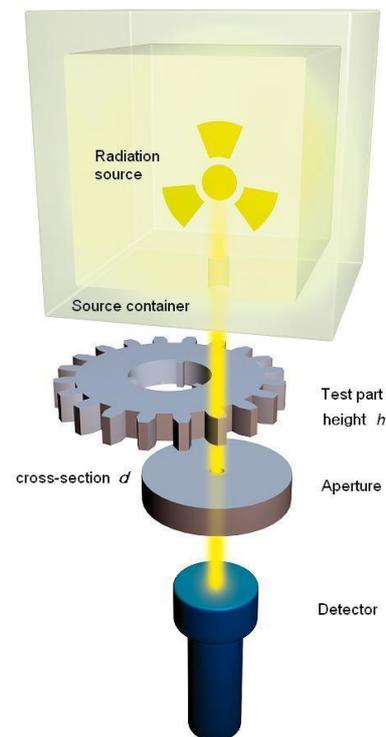
Principle of Measurement

The GAMMATEC Densitometer measures the attenuation of gamma radiation penetrating the test parts. As the capability of compacts to absorb this type of radiation depends on their density, the attenuation of gamma radiation can serve as a measure of the density.

Similar measurements are applied in the determination of the sheet thickness during the rolling of metal sheet, the monitoring of the conveyor belt loading in surface mining or the fill height measurement of containers.

Gamma radiation is an electromagnetic radiation. It is comparable to X-rays, but it is not emitted by an X-ray tube. Instead, the gamma radiation required for the measurement is generated in the radioactive decay of radionuclides. The radiation sources are mounted inside shielding containers that are impermeable for the radiation. Radiation emerging from a collimator opening in the bottom of the shielding container passes through the test part where it is partly absorbed.

An aperture on top of the detector serves to screen out a well-defined beam of radiation. Only radiation reaching the detector through test part and aperture contributes to the measurement. The test volume, whose average density is measured, is defined by the size of the aperture. It is a channel with the cross-section of the aperture whose length is the height of the test part. The intensity of the radiation identified by the detector is the quantity used to determine the material density.



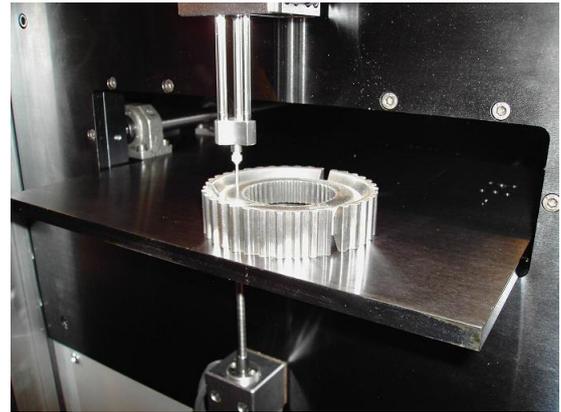
Schematic design of the GAMMATEC densitometer

Measuring Densities with the GAMMATEC Densitometer

Density measurements with the GAMMATEC Densitometer can equally be taken on pressed ('green') as well as on sintered compacts. The entire measurement is PC controlled and fully automatic. No special preparation of test parts and no skilled personnel is required. The parts are not in contact with a liquid or other harmful substances during the measurement, as is common with other test methods. The measurement is non-destructive, i.e. test parts are not affected in any way by the measurement. They can be further proc-

essed after being tested and do not have to be scrapped.

The GAMMATEC software was developed to meet the specific requirements of powder metallurgy processing. The user is given clear instructions on the screen, how and at which points of the test parts density measurements should be taken. He aligns his test part under the feeler gauge used for height measurement and starts the measurement by mouse click. At first the height is measured automatically and then the part is transferred into the test chamber and the density is measured by gamma radiation. At the end the result is displayed and saved along with the test parameters.



Test part on the sample tray

Benefits for the User

When parts are exhibiting local density variations, which is normally the case in powder compaction, sectional densities can be determined in different areas of the component without cutting it into pieces. This test method can be used to analyse non-uniform die filling and to develop better die filling techniques.

The density is measured in a very small volume of the test part. This method allows to determine local densities exactly where the highest loading occurs in a part.

All test results and acquired data are available on-line for further processing by in-house quality documentation and supervision of measurements.

Tool setting for multi-level components can be much improved by using the GAMMATEC Densitometer. When installed on the press shop floor, it can be operated by the tool setter himself. With the test result he can immediately return to the press and implement the corrections or start the next production run. Transfer of sample parts to the lab for density testing can be eliminated and results for the correction of tool settings are more readily available. This helps to reduce the time required for tool setting and clearly improves the productivity of powder presses.



The GAMMATEC Densitometer

Wide Range of Application

Density measurement with the GAMMATEC Densitometer is primarily used to determine sectional densities of green compacts and sintered parts. The range of materials where this method can be successfully applied covers the entire periodic system of the elements. It reaches from the light elements such as graphite via light metals (Al, Mg, Li, Ti) and their alloys, ceramics (Al_2O_3 , SiC, Si_3N_4 , ZrO_2 , ...), magnetic materials (hard and soft ferrites, Alnico, Nd-Fe-B, ...), metals including iron and alloy steels, Cu, Ni and Co based alloys to refractory and heavy metals (W, Mo,...) as well as hardmetals (cemented carbides).

Easy Operation

The user is guided through each step of the density measurement by an inspection plan with exact instructions where to take measurements on his test part. The inspection plan also allows to document all measurements.

A picture of the test part shows at a glance how to align the part and where the test points are located. The test parameters for each test point are included in a table. Two options, tool set-up and regular production runs, as well as the processing step that has last been performed on the part, are selected for documentation purposes. An order or batch number and an arbitrary comment can further be entered in order to identify the production run. Then the operator only clicks on the 'Start' button and the measurement runs fully automatic.

Density measurement

Part: Synchro hub P | Material: Distaloy AE + 0.6 C | Work status: Pressed

Notice: Identification mark on the left.

Order/batch: 063376-06 | Comment (max. 24 char.):

Setup/production: Setup (S) Production (P)

Green density does not include lubricant!

TP	Source	Aperture	Time	Dens requ.	Dens min	Dens max	Height P2	Diff.
1	Cs	∅ 3.0	20	7.100	6.950	7.200	26.000	0.000
2	Cs	12.0x4.0	30	7.200	7.050	7.300	0.000	0.000
3	Cs	∅ 3.0	20	7.100	7.000	7.250	21.000	0.000

Density without lubricant: **7.046 +/- 0.012 g/cm³** | Correction: -0.76 % | Density difference: 0.000 g/cm³ | Density P2: 7.317

TP: 1 | NO [cps]: 59470.2 | Height: 27.000 mm | N [cps]: 14907.6

Height measurement: Automatic Keyboard

Buttons: Open door, Close door, Start, Results, Unregister

User: Supervisor | 14:36:55 | 01-06-2006 | © 2004 Gammatec C 3.4 Demo Version

Densitometer screen for density measurements

Further options offered by the software are:

1. Calculation of the density without lubricant

When measuring green part densities, the lubricant content can be deducted.

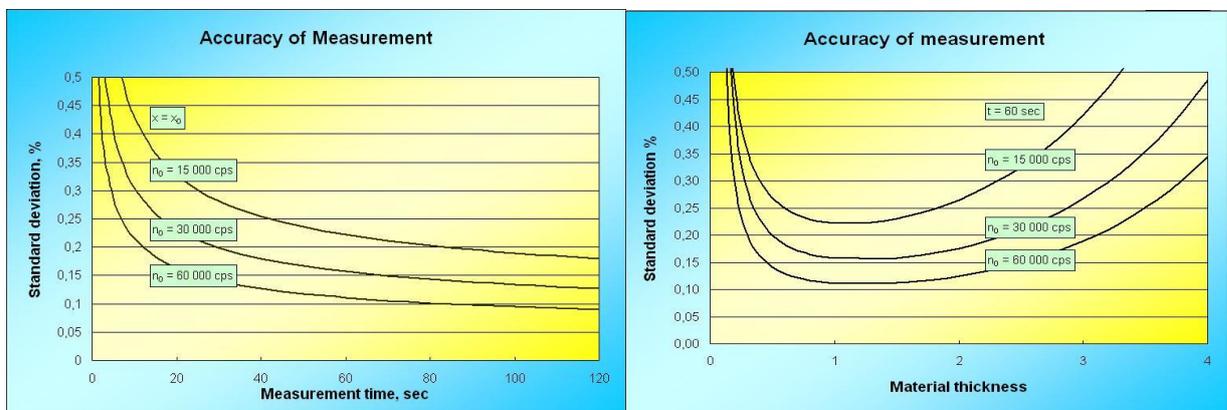
2. Differential measurement

In addition to the density, the difference of the result in comparison to another test point or the difference between several test points is used for the good/bad decision.

3. Anticipation of sized density

Based on the height of the green or sintered compact and the expected height of the sized component, the density after sizing is calculated in advance. The result allows to predict a risk of excessive tool loading during sizing or warns if the required final density cannot be achieved at all.

Accuracy of Measurement



Accuracy of measurement depending on measurement time and material thickness

The accuracy of measurement depends on the measurement time. It improves with increasing measurement times. Reliable results can be obtained even after a few seconds. Practical measurement times are between 10 and 120 seconds.

Further, the intensity of the radiation (count rate n_0) has an effect on the accuracy. The two diagrams on this page show the accuracy of measurement for three different count rates.

The energy of the radiation should correspond to the material composition and the sample thickness. There is an optimum thickness x_0 for each material composition where the accuracy of measurement is best. The value of the optimum thickness depends on the radiation energy.

After a measurement time of 60 seconds, the standard deviation (statistical scatter of results) can be less than 0.1 percent of the mean value under favourable conditions. Practical standard deviations are usually between 0.2 and 0.3 percent.

Radiological Safety

The gamma radiation required for the measurement is generated by radioactive sources which are produced by nuclear technology. These nuclear materials are safely encapsulated in stainless steel so that no radioactive material can escape from the protective container.

The radiation shielding of the densitometer is so effective that there is no elevation of the natural radiation level outside the instrument. Even in case of malfunction, loss of power or air pressure and incorrect operation, the escape of gamma radiation from the instrument is positively prevented.

The GAMMATEC Densitometer is subject to the strict regulations for the use of radioactive materials. The design for radiological safety is based on the legislation of Germany. Deviating regulations may be valid in other countries.

In general, users will be requested to attend to the following duties:

1. Apply for a license for the radioactive sources installed inside the densitometer.
2. Assign a Radiological Safety Commissioner who has received a training in radiological safety regulations.
3. Register the device with local authorities and inform the local fire department of the location and type of radioactive material so that suitable action can be taken in the case of fire.
4. Regular leak-proof testing of the source capsules (wipe test usually after the first year and then every 3 years).
5. Inform the operating personnel of the presence of radioactive material inside the densitometer and of the radiological safety installations of the instrument.
6. No unauthorized modifications shall be made on any installation serving radiological safety.

After termination of their service life (generally after 15 years), radiation sources shall be returned to an authorized organisation either for further use or for disposal. Trained personnel is required to mount and dismount the sources.

GAMMATEC offers its customers full support for the registration of the densitometer and provides any required service in order to make sure that your densitometer is always safe and reliable measuring density.