32 the sample

ISSN 0949-6025

Information from the field of solids preparation and characterization in laboratories and processing industries

SAMPLE PREPARATION
for Instrumental Analysis

- Traces of Heavy Metals in Toys
- Fat Analysis in Food and Feed
- Detection of Mycotoxins in Nuts
- Sample Preparation for XRF
- Particle Analysis of Grinding Balls

EDITORIAL

Dear Readers, Customers and Business Partners,

in the new issue of our customer magazine "the sample" we are taking a closer look at "sample preparation for instrumental analysis". Sample preparation is a very important part of the analytical process; however, it isn't always given the necessary care and attention. This eventually proves to be a mistake because sample preparation which is carried out neither reproducibly nor representatively will lead to falsified and unreliable analysis results.
Thanks to the wide range of mills and grinders, RETSCH offers a suitable instrument for a great variety of analytical methods. In this issue we present a selection of the methods which are most widely used: AAS, HPLC, NIR and XRF. For each of these methods certain requirements have to be fulfilled by sample preparation; RETSCH has the right instrument for each requirement.
Of course we also present you with interesting applications from the field of particle analysis which plays a decisive role in quality control. In this edition you can read about size and shape analysis of grinding beads with the CAMSIZER.

We hope you enjoy reading this issue!

Yours

Dr. Jürgen Pankratz
Managing Director

1,000 test reports for free

For many decades RETSCH has been offering free trials to customers to find out which instrument is best suited for a particular application. From a pool of more than 15,000 test grindings, the most frequent applications have been selected, anonymized and their test data are now available for download in the extensive online data base on the RETSCH website. The documents dealing with such different sample materials as algae, bones, tires or iron ore help the user to get a first orientation as to which mill might be suitable for his specific size reduction task. The well-structured data base allows to search by material, instrument, application field or feed size. Access to RETSCH's online data base is completely free, no registration or login is required.

www.retsch.com/applicationdatabase

The selection of the appropriate mill depends on a variety of parameters of the actual application - please contact us to discuss the right solution for you.

NEW: DVD WITH ALL PRODUCT VIDEOS

The operation & application videos of all major RETSCH instruments are now available in 4 languages (German, English, Spanish, Japanese) on one DVD! If you would like to receive your personal copy, send an email to **mk@retsch.com**.

Traces of Heavy Metals in Toys

Toys must be safe. That is very clearly stated in the European Directive 88/378/EWG which stipulates the maximum permissible values of substances such as arsenic, lead, cadmium or antimony in toys. The amounts must be below the level which could be harmful for children. During the last few months, several cases were covered by the press where harmful amounts of heavy metals had been detected. With the growing media coverage of this problem, the insecurity of the consumers grows as well. Therefore, it is in the very own interest of toy manufacturers to prove by a reliable quality control the innocuousness of their products.

From Size Reduction to Analysis

Atomic Absorption Spectroscopy (AAS) is very suitable for the detection of traces of heavy metal in plastics. The method is easy and inexpensive and the results show good precision and accuracy. With AAS only dissolved substances can be analyzed, therefore, the sample must first be ground and then digested. Usually, the sample preparation takes up much more time than the actual analysis; moreover, it can be a source of errors not to be underestimated. If, for example, a sample is reduced in size with scissors or a household mixer, falsified analysis results due to contamination are inevitable.

With a plastic doll as an example, this article describes the exact working steps from the neutral-to-analysis sample preparation to the final analysis result. To control the accuracy of this method, reference materials were bought and analyzed as well.

HEAVY-DUTY CUTTING MILL SM 2000

- Feed material: soft, medium-hard, tough, elastic, fibrous
- Material feed size: < 60 x 80 mm
- Final fineness: 0.25 - 20 mm

MIXER MILL MM 400

- Feed material: hard, medium-hard, soft, brittle, elastic, fibrous
- Material feed size: ≤ 8 mm
- Final fineness: ~ 5 µm

SM 2000

Preliminary and fine size reduction of the sample

First of all, the components of the doll are separated into 3 different analysis groups: body, hair and dress.

In a first step, the doll's body is pre-cut to a fineness of approximately 3 to 4 mm in RETSCH's **Heavy-Duty Cutting Mill SM 2000.** With its offset hard-metal cutters and powerful drive it is ideally suited for the preliminary size reduction even of heterogeneous sample materials. The sample is then divided into representative sub-samples with the help of the rotary tube divider PT 100 which provides a very high division accuracy. The sub-sample is further homogenized in the **Ultra Centrifugal Mill ZM 200.** It achieves a final fineness below 200 µm in a very short time and is gentle on the material. It is recommendable to use **dry ice as a grind-**

Microwave Digestion

© CEM GmbH

After the mechanical preparation of the doll, the next step is microwave digestion, before the sample is finally analyzed in liquid form. The objective is the complete digestion of the sample with the digestion solution containing all elements and compounds which are of interest in an unaltered quantity. Inorganic substances should be transformed completely into soluble components whereas organic substances should be mineralized.

The ground parts of the doll (approx. 500 mg) are weighed in the digestion container and 10 ml nitric acid are added. The digestion process is then started software-controlled. The temperature development of all samples is continually measured and adapted to the specified digestion profile, depending on the reaction development. After **only 30 minutes** the samples are digested and can now be filled to the nominal volume for the subsequent analysis in the Atomic Absorption Spectrometer.

© CEM GmbH

For trace element analysis the following requirements have to be fulfilled:

- The digestion should be **easy** to carry out, i.e. without great effort and complicated instruments.
- The procedure should be **safe,** i.e. the microwave should possess all necessary safety features.
- The digestion process should be optimally adjusted to the complete analysis procedure so that, for example, the digestion acids don't cause a matrix extension.
- Digestion parameters should be recorded and controlled to guarantee **reproducible conditions.**

Nowadays it is no longer efficient to let the sample boil for hours in concentrated mineral acid on a heating plate. **Microwave digestion systems** are designed to dissolve a solid sample in a very short time. This **time benefit** is achieved due to the direct heating of the solution by microwaves, the quick cooling down after digestion and temperatures far above the regular boiling point of the digestion acids.

ing aid as cooling not only improves the breaking properties of the material but also helps to preserve volatile substances which might otherwise be affected by the frictional heat.

The doll's **hair and dress** are ground in the **Mixer Mill MM 400** which can process two samples of 20 ml within 1-2 minutes. The screw-top grinding jars are filled with sample material and are then **pre-cooled in liquid nitrogen** before being clamped into the mill.

All mills described here can be equipped with **heavy-metal-free grinding tools** thus avoiding the risk of falsifying the analysis results due to contamination.

MM 400

Analytics

The samples are analyzed with Graphite Tube AAS to allow for a low detection level. For this method, 5 to 50 microliters of sample solution are put into the graphite furnace and are then heated step by step to such a degree that the sample is atomized. Modern spectrometers with fixed lamps and a motor controlled mirror allow for the rapid, fully automatic quantitative analysis of several elements.

The doll was analyzed for traces of the toxic heavy metals arsenic (As), cadmium (Cd), lead (Pb) and antimony (Sb).
The results:

element	dress	hair	body
	mg/kg	mg/kg	mg/kg
arsenic	–	–	–
cadmium	–	–	31 ± 1
lead	–	–	–
antimony	32 ± 3	–	–

Traces of cadmium were detected in the doll's body and of antimony in the dress. The concentrations are below the recommended limits for toys (Cd: 75 mg/kg; Sb: 60 mg/kg), however, the amount of antimony in the dress is already critical when compared to the values that voluntary seals of approval for ecologically compatible textiles such as Oekotex 100 recommend (30 mg/kg).

To verify the accuracy of the complete procedure, reference materials were analyzed as well. Five plastic samples were obtained from the Association of the German Automobile Industry (VDA) which contained different amounts of cadmium.

sample	certified value	measured value
	mg/kg	mg/kg
1	114.6 ± 2.1	114.0 ± 1.0
2	40.9 ± 1.2	40.5 ± 0.6
3	75.9 ± 2.1	75.7 ± 1.0
4	197.9 ± 4.8	196.8 ± 1.3
5	407 ± 12	403 ± 6

As the analysis results (average of three independent microwave digestions) come very close to the reference values it can be summarized that the procedure described in this article is very well suited to analyze traces of heavy metals in toys. The results obtained are accurate and highly reproducible and the complete process can be carried out within a couple of hours.

Fat Analysis in Food and Feed

The fat content is one of the most important parameters for the quality control of food and feed. On the one hand, the fat content contributes greatly to the nutritional value of a product; on the other hand, some fats (e.g. milk fat or cocoa fat) are quite expensive components and should therefore be used economically. Due to the new EU directives about the labelling of food with terms such as "light" or "low fat", it is now up to the manufacturers to indicate the true fat content of their products on the wrapping.

ZM 200

ULTRA CENTRIFUGAL MILL ZM 200

- Feed material: soft, medium-hard, brittle, fibrous
- Material feed size: < 10 mm
- Final fineness: < 40 µm
- Wide speed range, adjustable from 6,000 to 18,000 min^{-1}
- Gentle and very rapid size reduction by 2-step rotor/screen system
- Comfortable parameter setting via display and ergonomic 1-button operation
- Quiet and reliable, easy to clean

Fat analysis methods

There are various methods of quantitative fat analysis. Which method is applied depends on the sample material, the required accuracy and the time frame. **Solvent extraction** according to **Soxhlet** and **Weibull-Stoldt** are two of the classic methods where the sample is submitted to acid digestion before the extraction. Soxhlet extractions are usually automated, several samples can be processed simultaneously. These systems offer various benefits such as easy handling, solvent recovery, safety features and a small footprint. The programmability of time and number of extraction cycles guarantees an extraction under reproducible conditions. In addition, the possibility to select individual heating plates helps to save energy.

Size reduction of samples with a high fat content

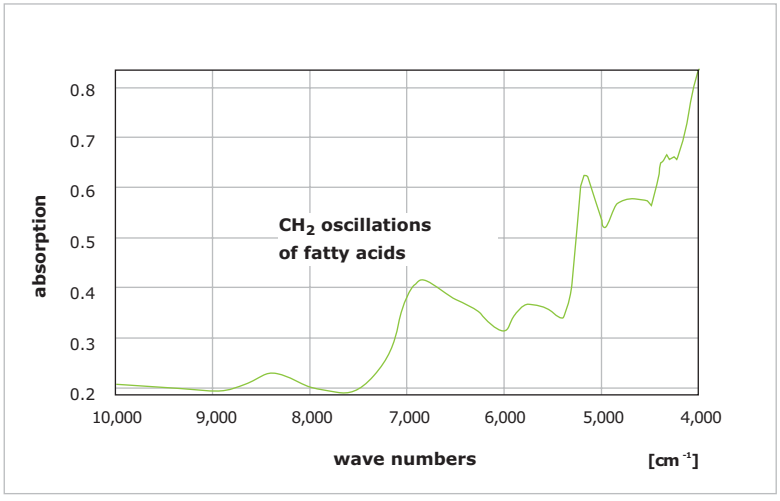
To determine the fat content by quantitative extraction, it is necessary to prepare the sample beforehand. During the preparation process care must be taken that the properties to be determined – in this case the fat content – are not altered in any way. If the size reduction is carried out incorrectly, a loss of fat cannot be avoided as the use of unsuitable accessories and incorrect operation parameters inevitably leads to fat residues inside the grinding chamber and on the grinding tools. The sample must then be rejected and the mill must be cleaned.

RETSCH offers two mills for the size reduction of materials which contain fat or oil. The **Ultra Centrifugal Mill ZM 200** is a rotor mill which is used for the fine size reduction of medium-hard products with a moderate fat content such as oil seeds, cookies, feed pellets or dog food. The sample is ground mostly by shearing effects between the rotor and a fixed ring sieve. The aperture size of the ring sieve determines the degree of fineness. For fat analysis through extraction, a final fineness of 0.5 to 1 mm is usually sufficient which can be achieved with aperture sizes of 0.75 to 1.5 mm. The use of smaller sizes can lead to fat separation, therefore, the rule "not as fine as possible, but as fine as necessary" should be followed.

The **Knife Mill Grindomix GM 200** is preferably used for materials with a high fat content such as fish pellets, meat, sausages or cheese. This mill grinds and homogenizes the sample through cutting effects in a liquid-tight container. The final fineness and the degree of homogenization are determined by the variable speed. The grinding process can also be carried out in a liquid phase, e.g. the extraction medium. Thus, the loss of fat can be successfully avoided if the complete contents of the container is transferred to the extraction thimble.
Both mills work absolutely reliably, provide reproducible results and can be equipped with **heavy-metal-free grinding tools.**

Ultra Centrifugal Mill ZM 200

Knife Mill Grindomix GM 200



NIR spectrum of dog food

The pictures show a ground dog food sample and the corresponding NIR spectrum. It takes only 1 minute to grind 150 g of this sample to a fineness below 1 mm in the ZM 200. Within a few seconds it is possible to obtain an NIR spectrum which allows a reliable quantitative statement on the fat content of the sample.

NIR Spectroscopy

In addition to the classic extraction methods according to Soxhlet or Weibull Stoldt, Near Infrared (NIR) Spectroscopy has established itself as an alternative. This method not only allows for the determination of the fat content **within seconds** but also of further important parameters such as **protein, humidity and carbohydrates.** Moreover, NIR spectroscopy is carried out without the use of chemicals and can be applied close to the production process. The instruments feature a user-friendly operation panel and are very easy to operate.

For quantitative NIR analysis, inhomogenous samples can be a problem. If the concentration of fat is not distributed homogenously, the results can vary greatly, depending on the part of the sample which was analyzed. To avoid this, **it is important to carry out reproducible size reduction of the sample before it is measured in the spectrometer.**

Dog food pellets before size reduction

The grinding result shows a fineness of < 1 mm

Detection of Mycotoxins in Nuts

Mykotoxins are natural metabolism products of molds which have a toxic effect on humans and animals. Just like micro-organisms which generate antibiotics, molds which generate mycotoxins have spread all over the world. Aflatoxins are the most toxic form of mycotoxins. Some types of food show an increased risk of aflatoxin release due to fungal infestation: dried fruit, spices, nuts (peanuts, hazelnuts, pistachios) and grain (wheat, corn).

Hazelnuts before grinding

The result of preliminary size reduction

Mycotoxins need certain conditions of temperature and humidity to form as well as sufficient nutrients. These conditions often occur with food when it is stored too long and in an unsuitable way. The result can be a complete family of chemical compounds instead of only one substance. As mycotoxins are temperature-resistant they are usually not destroyed when the food is processed.

Preliminary and fine size reduction

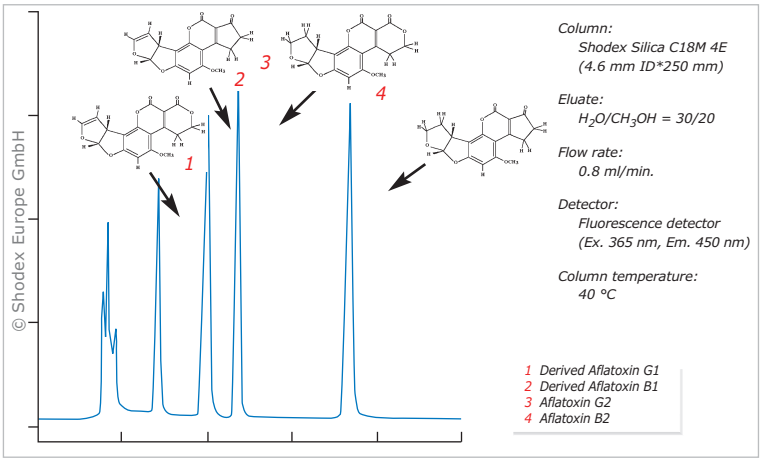
For a sufficient extraction of the mycotoxins from the initial product, the sample must be reduced in size and homogenized. As the maximum permissible mycotoxin values range between 0.025 and 15 µg/kg and fungal infestation usually occurs in nests, a random sample taken from the bulk must be sufficiently large to allow for the detection of contaminants. The first step is the preliminary size reduction of a representative amount of 1 - 2 kg per ton of nuts with the RETSCH **Cutting Mill SM 100** to a particle size of 1 - 3 mm. This mill is suitable for the rapid and gentle size reduction of dry materials down to a fineness of 0.25 mm. The sample is then divided into representative sub-samples with the help of the rotary tube divider PT 100 which provides a very high division accuracy.

The subsequent fine size reduction is ideally carried out with RETSCH's **Ultra Centrifugal Mill ZM 200.** This powerful rotor mill is easy and safe to operate and very versatile due to a wide selection of accessories. For the processing of hazelnuts, the use of **distance sieves** is recommendable which have been specially developed for grinding temperature-sensitive brittle materials. As mycotoxins are lipophilic, the grinding process should be as gentle as possible to avoid the release of fat from the sample. A fineness of 300 µm is sufficient for the subsequent extraction of the mycotoxins from the sample.

Extraction

For the extraction 25 g of the homogenized sample are shaken in 200 ml water/acetonitrile (16+84 v/v) for 60 minutes and are then filtrated. 100 ml of the filtrate are extracted with 100 ml petroleum ether. The petroleum ether phase can be disposed. An aliquot of the remaining phase is mixed with activated carbon / Al_2O_3 / Celite (7:5:3 - w/w/w) for 10 minutes and then centrifuged. The supernatant is evaporated and resolved in water. The solution is introduced to an immuno-affinity column, washed with water and eluted with methanol. The eluate can then be analyzed by HPLC.

High Performance Liquid Chromatography



The graphic shows a typical chromatogram of a sample containing aflatoxin. It is possible to determine the type of mycotoxin as well as to make an exact statement about the quantitative contamination.

High Performance Liquid Chromatography (HPLC) is an analysis method which has various advantages such as **high selectivity and reproducibility** and **very low detection levels.**

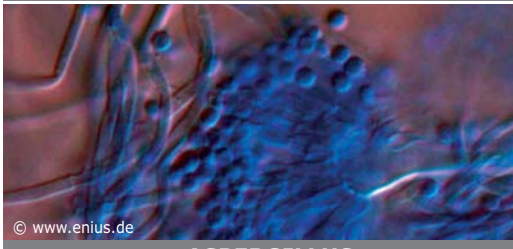
For sample preparation, immuno-affinity columns are available for solid phase extraction (SPE). Retaining the aflatoxins on selective binding antibodies they are separated from the matrix and afterwards released by elution with organic solvents. The resulting extracts can be analyzed by RP18-HPLC detecting the mycotoxins by fluorescence after post-column derivatization with bromine or iodine solutions.

Often entire ship loads of nuts or similar products cannot be released before the aflatoxin content is determined exactly. The method described here provides representative results in a very short time thus giving the supplier as well as the consumer optimum protection.

MOLDS WHICH GENERATE MYCOTOXINS

ALTERNARIA

PENICILLIUM



ASPERGILLUS

SM 100

CUTTING MILL SM 100

- Feed material: soft, medium-hard, elastic, fibrous
- Material feed size: < 60 x 80 mm
- Final fineness: 0.25 - 20 mm
- Defined final fineness by use of bottom sieves
- 3 different hoppers for different materials
- Samples subjected to low thermal stress

Sample Preparation for XRF Analysis

The main objective of x-ray fluorescence analysis is the quantitative determination of elements which requires a high degree of accuracy and reproducibility. Both parameters are directly related to the quality of the sample preparation.

RS 200

Homogenous particle sizes ensure good reproducibility

The reproducibility of solid samples depends directly on the particle size and density of the prepared sample. In XRF, the intensity of the scattered light is an indicator for the quantity of an element. If the sample is too coarse, the x-rays are strongly scattered by the particles which leads to an increase of the intensity regardless of the actual quantity of the element. Therefore, it is of great importance for reproducible quantitative analyses that the required degree of homogenization is achieved and the size distribution remains constant from sample to sample. The graphic "grinding time" shows that already after 2 minutes grinding time in the RETSCH Mixer Mill MM 400, the intensity of the signal reaches a constant value which does not change after longer grinding.

Apart from the particle size, the density of the sample is also a decisive criterion. When pressing pellets care must be taken that the air is evacuated completely. In the graphic "pressure" it can be observed that the intensity reaches a constant value when the sample is pressed with a pressure of 20 tons because then the maximum density is achieved. **Only sample preparation which guarantees a uniform particle size distribution and density of the sample leads to a high degree of accuracy and reproducibility of the analysis.**

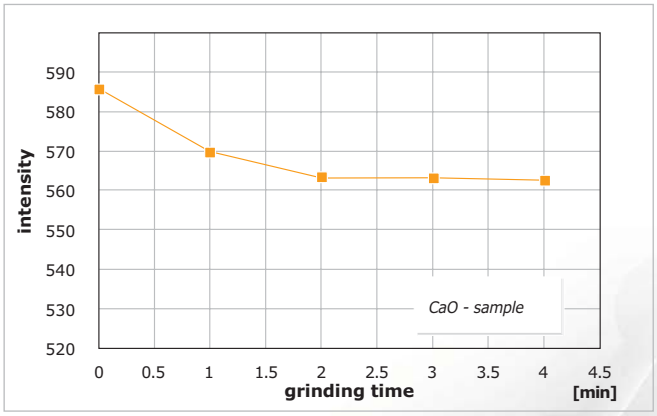
If necessary, the sample can be submitted to preliminary size reduction in a jaw crusher. The mill which is most frequently used for fine size reduction of hard and brittle products for XRF analysis is a **Vibratory Disc Mill** like RETSCH's **RS 200.** The grinding tools inside the jar, a disc and a ring, are moved by an imbalance in such a way that the sample is ground by pressure, impact and friction. This size reduction principle guarantees the required **reproducible analytical fineness** of < 100 µm after **very short grinding times.** This is a big advantage in quality control as the release of a product may depend on the analysis results which are therefore needed quickly.

Smaller sample volumes can be processed in RETSCH's Mixer Mill MM 400. The grinding jars perform radial oscillations in a horizontal position, the sample is homogenized very effectively by impact and friction. Both the Vibratory Disc Mill RS 200 and the Mixer Mill MM 400 can be equipped with grinding tools of various materials allowing for sample preparation without contamination with regards to the elements to be determined.

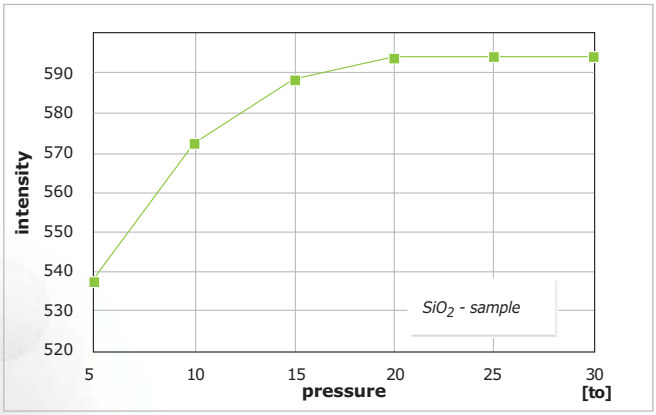
Soft, elastic materials such as **plastics** are best ground by shearing and cutting effects. For this, **rotor and cutting mills** are used where the desired final fineness is influenced by exchangeable bottom sieves with defined aperture sizes.

From sample to pellet

When the sample is ground to a homogenous fineness, it can be pressed to a pellet. For the mechanical stability of the pellet it is often necessary to add a binding agent. Two methods are possible: The pellet, agent is added as a grinding aid in the form of powder or tablets or the ground sample is mixed with the binding agent afterwards. **In the Mixer Mill MM 400, the sample can be mixed with the binding agent in a special polystyrene beaker.** Both methods have pros and cons and have to be selected according to the objective of the analysis.



Principle of the relation between XRF intensity and grinding time. The sample was homogenized in a RETSCH Mixer Mill MM 400.



Principle of the relation between XRF intensity and pressure. The pellet was pressed with the RETSCH Pellet Press PP 40.

Fusion melt

If not enough sample material is available, pressing with boric acid can be an alternative. However, particle size effects in the pellets limit the maximum reproducibility which can be achieved with this method. This problem can only be avoided by using fusion melt. Here, the finely ground sample (< 60 - 100 µm) is digested in borate at a temperature above 1,000 °C. This process destroys the original sample and creates a homogenous glass with a defined matrix. The greater reproducibility is achieved thanks to the lack of particle size effects, a better homogeneity and a defined density. Due to the dilution with borate, fusion melt is mainly used for the precise determination of major components whereas trace elements are rather detected with the help of pellets. For routine samples, where precision doesn't need to be too high, a pellet is also sufficient.

For reliable and reproducible applications in XRF, many parameters have to be controlled. It is very important to adapt the sample preparation process to the particular task. Therefore, the instruments used (mill, press, fusion machine) must feature flexible parameter settings and the user should have the necessary know-how.

MM 400

VIBRATORY DISC MILL RS 200

- Feed material: medium-hard, hard, brittle, fibrous
- Material feed size: < 15 mm
- Final fineness: < 40 µm
- Excellent reproducibility
- Analytical fineness in seconds

MIXER MILL MM 400

- Feed material: hard, medium-hard, soft, brittle, elastic, fibrous
- Material feed size: ≤ 8 mm
- Final fineness: ~ 5 µm
- High sample throughput due to short grinding times and two grinding stations
- Wide selection of grinding jar sizes and materials

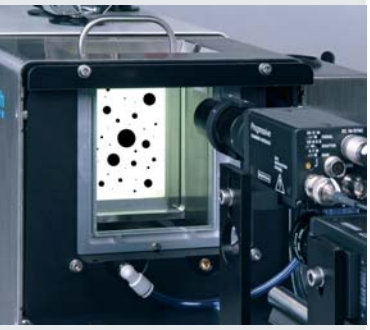
Particle Analysis of Grinding Balls

RETSCH Ball Mills are operated with grinding balls the size of which ranges from 2 mm to 30 mm. The amount and size of the grinding media used for size reduction depends on the properties of the material to be ground such as hardness, breaking behaviour, feed size and desired final fineness. The ball filling has a decisive influence on the grinding result.

CAMSIZER®

MEASUREMENT PRINCIPLE

The patented measuring setup of the CAMSIZER – two digital cameras as an adaptive measuring unit – improves and optimizes particle analysis by digital image processing. Therefore, it is possible to measure a wide range of particles from 30 µm to 30 mm with extreme accuracy without having to switch measuring ranges or make adjustments. The contact-free optical measurement is carried out in real time and simultaneously obtains all the required information about particle size and particle shape.



Sphericity as quality criterion

For an optimum grinding process, the balls should be equal in size and as round as possible. Figure 1 shows three different qualities of zirconium oxide grinding balls. It is easy to see that the B and C quality balls have a wider size distribution and even contain oval and non-round particles.

The optical particle measurement system **CAMSIZER** is able to **quantify these quality differences accurately.** The example demonstrates that the particle size distribution of the A quality balls (red) lies at exactly 3 mm and only shows slight variations whereas the B (green) and C (blue) quality products are much more inhomogenous. These considerable differences are also reflected by the **shape analysis.** Figure 2 shows the breadth/length ratio of the particles; it can be observed that the further the curve lies to the left, the more non-spherical particles the sample contains. Such illustrations make it very easy to recognize if grinding balls meet the high standards of a quality product. Therefore, the CAMSIZER is the ideal instrument for manufacturers and users to assess the quality of grinding media during production or to determine the degree of wear. It is possible to define thresholds and quality criteria with the function "image evaluation" which allows for the analysis of every single particle on previously saved pictures. The user sees the "bad" particles on these pictures and can call up the corresponding size and shape parameters (fig. 3).

The CAMSIZER offers many advantages compared to other measuring methods. A sieve analysis, for example, does not provide information on particle shape; moreover, the resolution is limited by the number of sieves used. The CAMSIZER, however, **saves the results in up to 1,000 size classes.**
With static image analysis methods the orientation of the particles can be a problem. Slightly lenticular grinding beads, for example, tend to show circular profiles which lets these particles appear rounder than they actually are. Compared to manual measurements with a calliper the CAMSIZER offers a much higher statistical security due to the measurement of larger sample quantities. Thus, it is also possible to recognize even small amounts of too large or too small particles.

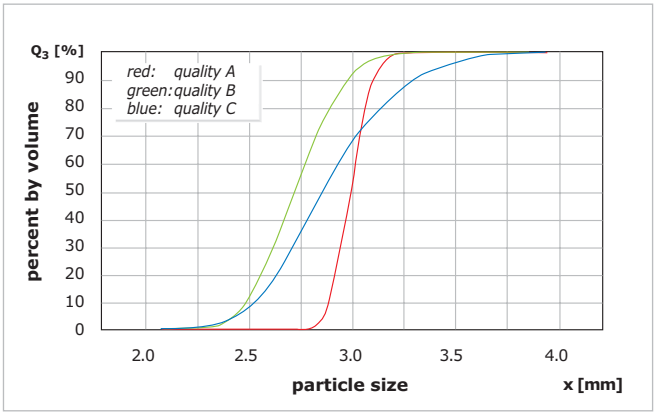


Fig. 1:
Particle size distribution of 3 different product qualities of zirconium oxide grinding beads. Beads of a lower quality show a wide variation around the mean value which is not exactly 3 mm.
Red: RETSCH grinding beads, the mean value is exactly 3 mm, the variation is insignificant.

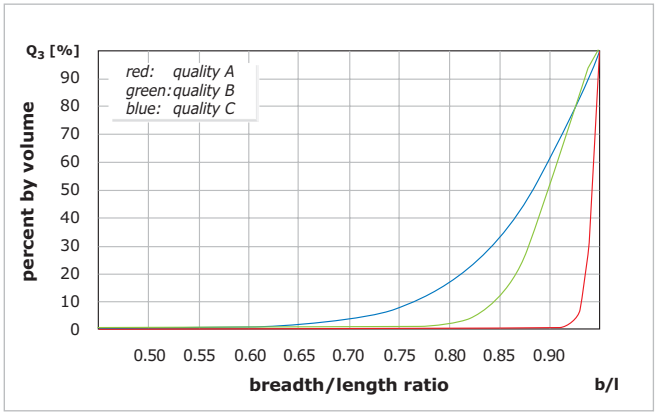


Fig. 2:
The grinding beads also differ in their shapes. The diagram shows the breadth/length ratio of the samples. The further the curve lies to the left, the less round are the particles. The RETSCH grinding beads (red curve) have a b/l ratio close to 1, i.e. they are almost perfectly round.

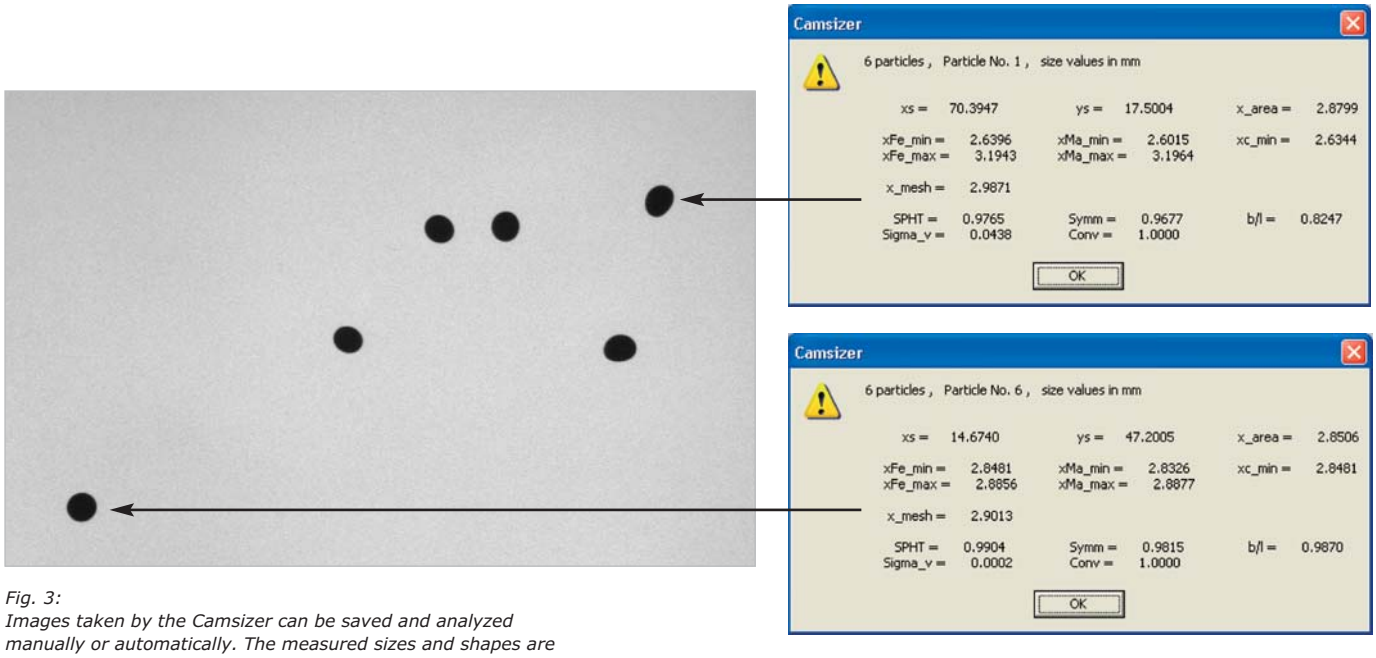


Fig. 3:
Images taken by the Camsizer can be saved and analyzed manually or automatically. The measured sizes and shapes are indicated for each particle. An almost perfectly round grinding bead (b/l: 0.987) can be seen in the lower left corner of the picture; a slightly oval particle (b/l: 0.825) can be seen in the upper right corner.

Solutions in Milling & Sieving

RETSCH GmbH is one of the leading international suppliers of laboratory instruments for the preparation and characterization of solids within the context of sample preparation and quality control. The wide range of products includes jaw crushers, mills, sample dividers, sieve shakers and optical particle sizers. Worldwide sales and marketing of the products is carried out in cooperation with qualified laboratory suppliers, subsidiaries and accredited distributors in more than 75 countries as well as directly to the end customers.

MILLING

Solutions for sample preparation for perfect analyses

For chemical and physical analytical methods it is essential that the specimen is perfectly homogenized to an adequate degree of analytical fineness. A reliable and accurate analysis can only be guaranteed by reproducible sample preparation. For these tasks RETSCH offers a comprehensive range of the most modern mills and crushers for coarse, fine and ultrafine size reduction of almost any material. The choice of grinding tools and accessories ensures that our instruments provide for contamination-free and reliable sample preparation prior to laboratory analysis.

Jaw Crusher
BB 51
www.retsch.com/bb51

Jaw Crusher
BB 100
www.retsch.com/bb100

Jaw Crusher
BB 200
www.retsch.com/bb200

Jaw Crusher
BB 300
www.retsch.com/bb300

Ultra Centrifugal Mill
ZM 200
www.retsch.com/zm200

Rotor Beater Mill
SR 200/SR 300
www.retsch.com/sr200
www.retsch.com/sr300

Cross Beater Mill
SK 100
www.retsch.com/sk100

Knife Mill
GRINDOMIX GM 200
www.retsch.com/gm200

Cutting Mill
SM 100
www.retsch.com/sm100

Heavy-Duty Cutting Mill
SM 2000
www.retsch.com/sm2000

Mortar Grinder
RM 200
www.retsch.com/rm200

Disc Mill
DM 200
www.retsch.com/dm200

Vibratory Disc Mill
RS 200
www.retsch.com/rs200

NEW

Mixer Mill
MM 200
www.retsch.com/mm200

NEW

Mixer Mill
MM 400
www.retsch.com/mm400

NEW

Planetary Ball Mill
PM 100 CM
www.retsch.com/pm100cm

Planetary Ball Mill
PM 200
www.retsch.com/pm200

Planetary Ball Mill
PM 400
www.retsch.com/pm400

SIEVING

Solutions for optimal quality control of solids
All RETSCH analytical sieve shakers of the model range "control" and all RETSCH test sieves can be calibrated and thus may be used in quality control according to DIN EN ISO 9000 ff.

WINDOWS™ based software solutions and extensive accessories support professional particle size analyses in modern laboratories.

Sieve Shaker
AS 200 basic/digit/control
www.retsch.com/as200

Sieve Shaker
AS 300 control
www.retsch.com/as300

Sieve Shaker
AS 400 control
www.retsch.com/as400

Sieve Shaker
AS 200 tap
www.retsch.com/as200tap

Test Sieves
www.retsch.com/sieves

Evaluation Software
EasySieve®
www.retsch.com/easysieve

ASSISTING

Solutions for more efficient crushing processes and sieve analyses
RETSCH sample dividers stand for representative sampling. For retained, documentary samples for chemical and physical analyses or for inter-laboratory tests, RETSCH sample dividers ensure exact, representative and reproducible division results.

The drying, cleaning and feeding machines from RETSCH with their versatility and ergonomic design perform these everyday functions both rapidly and accurately. All these machines are designed to make your work both easier and quicker.

Sample Divider
PT 100
www.retsch.com/pt100

Sample Divider
PK 1000
www.retsch.com/pk1000

Vibratory Feeder
DR 100
www.retsch.com/dr100

Rapid Dryer
TG 200
www.retsch.com/tg200

Ultrasonic Baths
UR 1/UR 2/UR 3
www.retsch.com/ur

Pellet Presses
PP 25/PP 40
www.retsch.com/pp40

Retsch® TECHNOLOGY

Innovative products for particle characterization

Operation & Application Video
www.retsch.com/camsizer

CAMSIZER®
- High resolution particle size and particle shape analysis
- Measuring range: 30 µm to 30 mm
- Measuring principle: image processing

www.retsch.com/camsizer

AutoSampler
- Fully automatic sample processing
- Continuous operation possible
- Barcode reader for sample recognition

www.retsch.com/autosampler

The RETSCH sister company RETSCH Technology GmbH in cooperation with Jenoptik AG offers high-quality optical systems to determine the particle size and distribution of dispersions, powders and granulates. For powders and granulates, an analysis of the particle shape is possible.

Rugged design for industrial environment, compact size and operational convenience distinguish the instruments of RETSCH Technology. Moreover, the systems are capable of automated and online operation in order to fulfill the increasing requirements of analysis and process engineering.

For more detailed information on optical particle sizers please visit

www.retsch-technology.com

RETSCH GRAND PRIX 2008

WIN WITH RETSCH HIGH-TECH PRODUCTS "MADE IN GERMANY"

Get on the race track of the RETSCH Grand Prix 2008 and win a high-class Mercedes sports car! Valuable prizes wait for you every other month such as a Mercedes Fitness Bike or a 10 MB digital camera from Leica.

WWW.RETSCH.COM/GRANDPRIX

(Legal action excluded, illustrations similar)

The first prize of the GOLD RUSH raffle was handed over in India!

Mrs Kavitha from Hyderabad was the winner of the RETSCH Gold Rush campaign and received the prize at Analytica Anacon in Mumbai from the local Retsch distributor Inkarp.

"When I received the email from Retsch, I was very excited and happy and couldn't believe that I had really won the first prize! My family was ecstatic and we had a big celebration. I would like to thank Retsch which is a trustworthy company and wish them great years ahead!"

Retsch®
Solutions in Milling & Sieving
www.retsch.com
a VERDER company

Your contact in Germany, UK and the US

Retsch GmbH
Rheinische Straße 36
42781 Haan · Germany
Phone +49 2129 55 61-0
Fax +49 2129 87 02
E-mail info@retsch.com
Web www.retsch.com

Retsch U.K. Ltd.
Whitehouse Street, Hunslet
Leeds LS10 1AD · Great Britain
Phone +44 113 2220 266
Fax +44 113 2465 649
E-mail info@retsch.co.uk
Web www.retsch.co.uk

Retsch Inc.
74 Walker Lane, Newtown
PA 18940 · United States
Phone +1 267 757 0351
Fax +1 267 757 0358
E-mail info@retsch-us.com
Web www.retsch-us.com