

## Colloidal Grinding

Fine grinding procedures, so called colloidal grindings, usually have to be carried out as wet grinding. To reduce the size of smaller particles by mechanical forces, a high energy input is necessary, such as it is generated by the High Energy Ball Mill E<sub>max</sub>. What is also important for a successful grinding is the selection of a suitable grinding set with the optimum filling of balls.



We recommend to carry out the following steps for colloidal grinding:

### Grinding Jar

Fine or finest grinding applications are often long-run procedures. This means that the grinding jars and balls are submitted to mechanical stress over a long time period. Therefore, the grinding tools must be of very good quality with a high abrasive wear resistance. High performance ceramics like yttrium stabilized zirconium oxide (YTZ) and tungsten carbide (WC) show these properties.

### Grinding Beads

Grinding beads or balls are generally made of the same material as the grinding jar. At least 60% of the jar volume should be used for the grinding beads. For example, a 50 ml grinding jar is filled with 30 ml beads of zirconium Ø 3 mm, this is a total mass of 100g.

### Feed Size of Sample

Colloidal grindings are usually carried out with grinding beads of  $\varnothing < 3$  mm. In this case, the material should have a feed size of 300  $\mu$ m or smaller. It might be useful to reduce the particle size down to this fineness by a short dry grinding beforehand.



### Quantity of Sample

In a 50 ml grinding jar with 30 ml grinding beads is still enough space for a sample quantity of 17 ml. This is approx. one third of the jar volume.

### Liquids

Colloidal grindings are only possible under liquid conditions. When choosing the liquid, care must be taken that it doesn't alter the properties of the solid sample. Alcoholic solvents and hydrocarbons, like isopropyl alcohol and petroleum spirit which have these properties, are often used for nano grindings. Recommended ratio of components solid : liquid = 2 : 1 (vol%) (to achieve a viscosity like motor oil)

### **Safety**

During the grinding process, excess pressure can develop in the jar, caused by frictional heat and the low boiling point of the used liquid, although the sample is cooled in the  $E_{max}$ .

Note: Check the o-ring sealing for possible damages before starting the grinding!

### **Machine Settings**

The recommended rotation speed lies between 1500-2000 rpm. During long-term grinding, the external cooling system should be connected to the  $E_{max}$ . Furthermore, the  $E_{max}$  displays the possibility to operate in the temperature monitored mode, so that the user can be sure, that a maximum temperature (set by user) is not exceeded. The grinding time depends on the required fineness.

### **After the Grinding Process**

When the grinding process is finished, it is possible that the jar has heated up to a temperature of 60 – 80 °C and more, including excess pressure in the jar.

Using protective gloves, the closed jar with the safety closure device should be placed in a water bath for a cool down period. After ambient temperature has been reached, the jar can be opened without risk.

### **Sample Recovery**

To separate the grinding beads from the sample material, the whole contents of the jar should be emptied into a test sieve with a collecting pan beneath. A short vibration on the Sieving Machine AS 200, will then complete the separation procedure. As the solvent evaporates quickly, the remaining material on the beads comes off in no time.

It should be taken into account that nano particles are to be classified as toxic, therefore it is recommendable to wear a mask when handling nano powders.

### **Cleaning**

For cleaning the grinding beads the Ultra Sonic Bath is quite suitable.