NANOTECHNOLOGY

CALCIUM AUTOMOTIVE BATTERIES FROM TAB

TAB Lead acid calcium starter batteries made with **nanotechnology** have unique characteristics such as:

+ positive plate active material incorporating a special liquid nucleation agent and
+ special curing chambers for the curing and drying process of these positive plates.

In standard technology battery tribasic lead sulphate (3BS) is used in the positive active material. Presence of tetrabasic lead sulphate (4BS) is not common, as the crystals are quite large (bigger than 10µm) and not unified. In newly developed **nanotechnology processes,** TAB have achieved almost 100% tetrabasic lead sulphate (4BS), and most importunately, TAB have achieved unified crystal structure of very small (less than 10µm) 4BS crystals. Consequently, batteries made with nanotechnology have several advantages over standard batteries. The most important of these is **longer lifetime** and **improved cycling characteristics** (discharge-charge), while there are also considerable improvements to **cold cranking performance** and **C20 Capacity.**

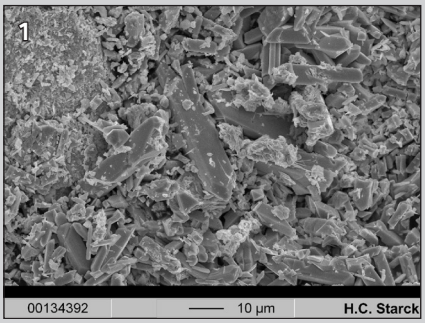
BASIC EXPLANATION OF NANOTECHNOLOGY

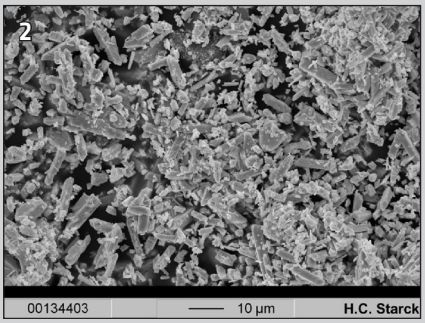
In standard technology we have (mainly) 3BS in positive active material. The 3BS crystals are smaller than 4BS. Charging the batteries with 3BS is consequently easier but capacity C20 is not stable because of loss of capacity during the batteries lifetime. The 3BS structure is fundamentally different, namely it progressively softens during the batteries lifetime in comparison to the 4BS structure. For this reason we can speak about an approximately 10% lifetime improvement over standard batteries.

Small nucleation particles of tetrabasic lead sulphate crystals in a classified and patented liquid additive of nanotechnology, known as 4BSA (Tetra Basic lead Sulphate Additive), are in the range <0,5µm and enable homogeneity growth of 4BS crystals in the positive active material. The final dimension of 4BS is less than 10µm (picture 1). This is important to provide stable capacity or C20. If 4BS crystals are larger than 10µm (picture 2), it is difficult to "utilize" all the active material in the battery (is difficult to formate and charge the battery) and capacity C20 is subsequently not stable. Therefore, with nanotechnology two goals, very small 4BS crystals are achieved.

A characteristic of standard ca/ca batteries is their difficulty in charging from deep discharge. With TAB nanotechnology, the active material remains conductive even if the battery is very deeply discharged and consequently re-charging of such a battery is much easier.

As a result, TAB nanotechnology batteries have stable capacity and can be easily recharged (even from a deep discharged state), resulting in improved cycling characteristics. For example, BMW cycle-ability test (50% DOD at 40°C) with TAB nanotechnology battery is fulfilled (requested 120 cycles and more), while with standard battery app. only 50 cycles are reached.





Last but not least, even small 4BS crystals are bigger and have bigger pore volume (high porosity of active material) than 3BS crystals in active material. Bigger pore volume allows better acid circulation. This feature provides the improvements in **cold cranking performance** (CCA) and **C20 capacity.**

TAB has introduced nanotechnology batteries in partnership with all it's OEM customers and in TAB's premium "quality and price" range batteries such as EcoDry, Topla Top and TAB Magic batteries.

PICTURE 1: Small particles of 4BS in the positive active material (Scanning electron microscope)

PICTURE 2: Big particles of 4BS in the positive active material (Scanning electron microscope)