FERROPERM
PIEZOCERAMICS A/S

FAQ's TO FERROPERM PIEZOCERAMICS

QUESTION

How does the Quality Assurance System in Ferroperm work?

How detailed the quality of my products documented?

ANSWER:

In Ferroperm Piezoceramics our general aim for our production is to have full traceability of all production steps in any order. We are therefore always able to go back to each operation and see if systematic problems have occurred with equipment etc.
This gives us a good possibility to perform corrective actions to direct or indirect problems seen in our own measurements, or noted in the customer's production or testing facilities.
We therefore always welcome a dialog regarding possible problems, and we encourage our customers to send back parts for inspection and re-measurements if there are any doubts regarding their performance.

The production in Ferroperm Piezoceramics comprises all steps of processing from reaction of raw materials in form of oxides, carbonates, organometallics etc. to the delivery of finished electroded and poled piezoceramic elements fulfilling customer drawings and specifications.

Based on 40 years of experience it is known that the only real test of the raw materials used in the production of piezoceramics is a pilot production of real piezoelectric parts.
As a consequence of this Ferroperm has taken a step further, and taken a decision to perform all production in the company **material-batch-specific**.

This means, that before any material is released for regular production, a pilot production has been completed, and all relevant parameters measured and approved. The data for a specific batch is saved in a data-base, which is used by the production manager to optimise the production parameters for each new production.
This system has several advantages over the more common method of using generic parameters or mean values from several earlier batches.

Examples:
If two batches have different sintering shrinkage the production manager will adjust the pressure in the uniaxial presses in order to obtain the same dimensions of a certain part from batch to batch.

If a customer has very tight tolerance on for example capacitance the production manager will select only batches with a very similar permittivity, whereby a constant capacitance and thickness can be obtained over deliveries of several years.

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The batch number is therefore the starting point for every new production, and will be clearly marked on both the production- and final inspection sheet.
In the production there are a number of different processes, which must be performed before a certain part is completed. Depending on the type of part, the processes can vary, but generally a full production requires one or more of the following operations:

- Pressing
- Binder burn-our
- Sintering
- Lapping
- Round-grinding (discs, tubes and rings)
- Dicing (plates or half-discs)
- Lens-grinding (focussing bowls or hemispheres)
- Electroding
- Poling
- Inspection

After each of these operations the responsible operator will record and register the time spend on a certain production number and the quantity and types of defects generated.

In Ferroperm Piezoceramics we have a system, where we differentiate between more than 120 different types of defects ranging from simple errors dimensional parameters to more complicated types such as discrepancies in certain piezoelectric parameters. By operating this differential system, a more systematic approach to problem-solving can be taken.
The registrations of processing personnel, production number and defect data are saved in a database, and can be accessed on-line from all computers on the intra-net.

After completed production all parts are passed through our final inspection unit. This department is a staff function under the managing director of Ferroperm Piezoceramics. Here qualified and well trained personnel uses modern and periodically calibrated measurement equipment to verify that productions fulfil the internal standards to the materials and the tolerances given by the customer.

The starting point for most control operations are the statistical sampling described in Military Standard MIL-STD-1050 (ISO 2602-1973). The accepted quality limit, AQL, is 0.65 - Sample plan 2. By operating this system, we secure that maximum 0,65% defect parts can be sent to a customer without seeing any problems during inspection. In the table below the consequences of operating the AQL is 0.65 - Sample plan 2 is shown.
In some cases customers have one or more critical parameters, where defects cannot be tolerated in spite of an increased cost of the parts. In such cases we can offer 100% inspection on these parameters.

Final inspection ***AQL 0.65 - Sample plan 2.***			
Quantity in the lot	**Samples From Lot**	**Accepted Defect Quantity**	**Unacceptable Defect Quantity**
0 - 280	20	0	1
281 - 1.200	80	1	2
1.201 - 3.200	125	2	3
3.201 - 10.000	200	3	4

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Example:

A batch of 2000 pcs piezoceramic discs come for final inspection, and no special control procedure has been specified. According to the table the final inspection unit will take a sample of 125 pcs out of that batch.

If they measure more than 2 defects on a certain parameter it is a sign, that a systematic error has occurred during production. A 100% sorting on that parameter must therefore be made on the entire lot.

If 0, 1 or 2 defects are found when measuring a certain parameter, the lot is approved, since the defects can be considered as unsystematic.

Any defect parts found in the sample are of course rejected and will not be sent to the customer.

On the following page a copy of the final inspection sheet used in Ferroperm Piezoceramics is shown.

We encourage all customers to consider and discuss the appropriate control level and number of parameters, which are relevant to check for a certain product with Ferroperm Piezoceramics as well as other suppliers of piezoceramics.

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Journ. No	Customer	Batch Pz	Type	Part (Dimensions in mm)	Drawing no.

Date of inspection	Lot size	Sample plan II	Sample size	Acc. Number	Rejection number
	Sublot no.	AQL 0,65:			

Temperature	Humidity	Remarks about origin or treatment of lot
°C	%RF	Control :

	Property	Unit	Tolerance	Measured Minimum	Measured Maximum	Mean within Sample	Remarks	Number of defects
1.	Outer dia. or length (Mi / Sc)	mm						
2.	Inner dia. or width (Mi / Sc / Int.gauges)	mm						
3.	Thickness or length (Mi / Sc)	mm						
4.	Radius of curvature (watch dial/UBM)	mm						
5.								
6.								
7.	Capacitance (HP 4278A)	pF nF					σ =	
8.	Dielectric loss tan s (HP 4194A)	%						
9.	Impedance spectrum (HP 4194A)							
10.	f_r / f_t (HP 4194A)	kHz MHz						
11.	K_p / K_t / K_{eff} (HP 4194A)	%						
12.	d_{33}	pC/N						
13.	*Dielectric Constant							
14.	*N_r / N_t	Hz m						
15.	Electrodes				Tape test or soldering test			
16.	Poling	Date	Direction of poling		Marking			
17.	Visual inspection							

Remarks		
	Numbers of defects in sample	
	Number of approved parts after sample test	
	Total number of rejects	
	Total number of approved parts after sorting	

*Calculated on parts with max. / min. Cap. /F_r / F_t Mi: Micrometer screw, Sc.: Slide caliper	Date of approval:	Sign.

Comments to final inspection sheet

The above sheet is a list of parameters, which are measured mechanically or in specialised electrical equipment.
As a standard procedure, the approved parts within the sample with minimum and maximum capacity are taken out, and an impedance plot is made. This impedance plot is a "finger-print" of this specific production showing where resonances are, and showing how strong the various coupling coefficients are.
The min and max capacitance often indicate the variation within the lot, since capacitance is linked to geometry and permittivity.

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