PAINT CHARACTERISTICS

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Various Kinds of Tests for paint Coatings

- **Paint Characterization**
  - Volume solid, Density, viscosity, drying and curing properties, in case of two components – mixing ratio, pot life
- **Mechanical Properties**
  - Hardness, abrasion, scratch, adherence, pullout strength, flexibility
- **Chemical Resistance Properties**
  - Salt Spray
  - weathering,
  - Humidity
  - Immersion tests
- **Permeability**

NON VOLATILE MATTER

Significance

- Indicates the weight solids in paint
- Higher solids means higher coverage

Stoving Method (IS 101 - Part 2/Sec 2)

- Weight 2 gms of sample in lid. Spread it across
- Place in oven at 105 Deg. C / 3 hrs or 120 Deg.C/1 hr
- Calculate the weight retained in percentage

DENSITY

Mass of a unit volume of a material at a specified temperature.

Weight per litre cup (IS 101 - Part 1/ Sec 7)

- **Cylindrical cup which can hold 100 ml of paint is used**
- **Determine the weight of the empty cup.**
- **Fill the cup with the paint and determine the weight.**
- **The difference in weight multiplied 10 gives WPL (weight per litre)**

Significance

- **If density is not within spec, then there is a good chance that there can be some error in charging of the batch.**
- **Can act as a check on the solids of paint.**

VOLUME SOLIDS

It is defined as the total volume of non volatile solids present in one litre of paint

Significance

- **A measure of spreading capacity of paint**
- **Higher volume solids product will give higher coverage at a given DFT**
- **It gives an indication of the amount of volatile solvents used in the paint**
- **Higher volume solids product are being preferred due to VOC regulations in developed countries**
- **High build products are designed with higher volume solids for higher thickness deposition per coat**

VOLUME SOLIDS

Volume solids - (ASTM D 2697)

- **Initially determine the % NVM by weight and WPL of the paint**
- **Take circular disc of 60 mm dia. and take its weight in air and in water.**
- **Apply the paint to the disc and allow it to dry.**
- **Take weight of coated disc in in air & in water.**
- **Volume solids is then calculated by formula .**

VOLUME SOLIDS

- W_1 = weight of disc in air, g : W_2 =weight of disc in water
- D = Density of water , g/ml
- **Volume of disc G** = $(W_1 – W_{2)}$ /D

- W_3 = weight of coated disc in air, g
- W_4 = weight of coated disc in water , g
- **Volume of coated disc H** = $(W_3 – W_{4)}$ /D

- **Volume of wet coating = F = H-G**

- **Volume of dry coating** =

$$V = (W_3 - W_1) / (\% NVM * WPL)$$

VOLUME SOLIDS

The volume solids is then calculated as below by

Formula

$$V.S. = \frac{\text{Volume of dried coating}}{\text{Volume of wet coating}} \times 100$$

COVERAGE CALCULATION

THEORETICAL COVERAGE

$$\text{Theo. Coverage } (M^2 / \text{lit}) = \frac{\text{Volume solids X 10}}{\text{DFT (Microns)}}$$

For a paint with 80% VS

Theo. Coverage at 100 µm DFT = 80 x 10/100

= 8 sq.mt / lit

PRACTICAL COVERAGE

Actual coverage of paint after taking into account all possible loss factors involved during the painting process

TYPES OF LOSSES DURING APPLICATION

- Paint loss during application may be due to :

  a) Apparent losses
  -- Effect of blast profile
  -- Paint distribution losses

  b) Actual losses
  -- Application losses
  -- Paint wastage

APPARENT LOSS
DUE TO EFFECT OF BLAST PROFILE

Surface	Blast Profile	DFT Loss *
Unblasted steel	0	0
Steel blasted using round shot	0 - 50 µ	10 µ
Fine open blasting	50 - 100 µ	35 µ
Coarse open blasting	100 - 150 µ	60 µ
Old pitted steel – reblasting	150 - 300 µ	125 µ

* DFT Loss - Addl. DFT required to Compensate blast profile

ACTUAL LOSS DUE TO APPLICATION METHOD

For Brush / Roller Application	**-- 5 - 10%**
For Air Spray	**-- 50-60%**
For Airless Spray	**-- 45-50%**
For Electrostatic Air Assisted Spray	**-- 30%**

The loss factor will also depend on :

- **Shape of structure**
- **Atmospheric Condition - Wind velocity**
- **Painting location e.g. Height**

APPARENT LOSS
DUE TO PAINT DISTRIBUTION

Application Method	Type of Structure	Estimated Loss (%)
Brush & Roller	Simple Structure	5%
-- do --	Complex Structure	10-15%
Spray	Simple Structure	20%
-- do --	Complex Structure	40%

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Higher DFT against minimum stated DFT due to uneven paint distribution / over deposition during application

ACTUAL LOSS
DUE TO PAINT WASTAGE

This is losses due to

-- Paint spillage due to handling

-- Retention in container / brush / spray line etc

-- Premature gelling during application (e.g. improper mixing ratio, high temperature etc)

Estimated Loss factor for

-- 1K Paint	**-- Max 5%**
-- 2K Paint	**-- 5-10%**

CALCULATION OF PRACTICAL COVERAGE

Application of 2K High Solid Epoxy Paint :

- 2 coat application / airless spray
- 100 microns / coat
- Sandblasted substrate - Sa 21/2 - 50 microns profile
- Complex object (confined space inside tank)
- Volume Solid - 80%
- Theoretical Coverage - 4 sq.mt / lit at 200 microns DFT

WHAT IS THE PRACTICAL COVERAGE ?

CALCULATION OF PRACTICAL COVERAGE

	First Coat
Required DFT	100 microns
Loss due to blast profile	10 microns
Loss due to distribution @ 40%	40 microns
(100 x 0.4)	--------------
	150 microns
Loss due to application @ 5%	7.5 microns
(150 x 0.05)	
Loss due to wastage @ 10%	15 microns
(150 x 0.1)	---------------
	172.5 microns

Extra Paint used -- 72.5%

CALCULATION OF PRACTICAL COVERAGE

	Second Coat
Required DFT	100 microns
Loss due to blast profile	Nil
Loss due to distribution @ 40%	40 microns
(100 x 0.4)	--------------
	140 microns
Loss due to application @ 5%	7 microns
(140 x 0.05)	
Loss due to wastage @ 10%	14 microns
(140 x 0.1)	---------------
	161 microns

Extra Paint used -- 61%

CALCULATION OF PRACTICAL COVERAGE

$$\text{Total loss for 2 coats} = \frac{72.5 + 61}{2} = 66.75\%$$

This means 66.75% extra paint is required w.r.t. theoretical quantity i.e. 1.67 lit paint is actually required to compensate all the losses.

CALCULATION OF PRACTICAL COVERAGE

Practical Spreading Rate =

$$\text{Practical Spreading Rate} = \frac{\text{Theo. Coverage / Lit}}{\text{Actual Paint Required}}$$

= 4 / 1.67 = 2.39 sq.mt. / lit

Overall Loss Factor = (4 - 2.39) x 100 / 4

= 40.25%

Utilisation Efficiency = 60%

VISCOSITY

Viscosity is the force per unit area that resists the flow of two parallel fluid layers

Significance

- **Flow and leveling properties**
- **Anti-sag properties**

Efflux Viscometers - Ford Cup (ASTM D 1200)

- **Brass cup - conical bottom - 4.12 mm orifice**
- **Used for low viscosity materials**
- **Measures the time taken for discharge in seconds**

VISCOSITY

Stormer viscometers - (ASTM D 562)

- **Paddle is immersed in the paint and load in weight applied through string**
- **Load required to produce 200 revolutions in 60 seconds is recorded**
- **Stroboscopic timer will indicate the motionless lines when 200 rpm is achieved**

DRYING TIME

Indicates the rate of drying / film formation of the paint film

Significance

- **Drying time depends on resin chemistry**
- **Can detect wrong mixing ratio / improper mixing in case of two pack products**
- **Slower drying time than specified - indicate slow curing and delayed / inadequate resistance properties**

DRYING TIME

Set to touch - (ASTM D 1640)

- **Lightly touch the paint film with the tip of a clean finger**
- **Immediately place the finger tip against a piece of clean glass.**
- **A film is set-to-touch when no coating is transferred to the glass plate**

DRYING TIME

Dust Free - (ASTM D 1640)

- **Cotton fibers are dropped on the paint film from a height of 1 inch**

- **The film is considered dust-free when a gentle current of air removes the fibre from the surface**

DRYING TIME

Tack Free - (ASTM D 1640)

- **Tack is the ability of a coating to hold an object**
- **Test paper is placed on the paint film**
- **Steel cylinder (2 inch dia, 2.85 kgs) is placed on the paper**
- **After 5 secs remove the weight and invert the test specimen**
- **If the paper falls within 10 secs the paint is said to be tack free.**

DRYING TIME

Dry Hard - (ASTM D 1640)

- Involves pressing the paint film with thumb
- If no noticeable mark is seen after the paint film is lightly rubbed with a soft cloth, the coating is said to be hard dry

Dry Through - (ASTM D 1640)

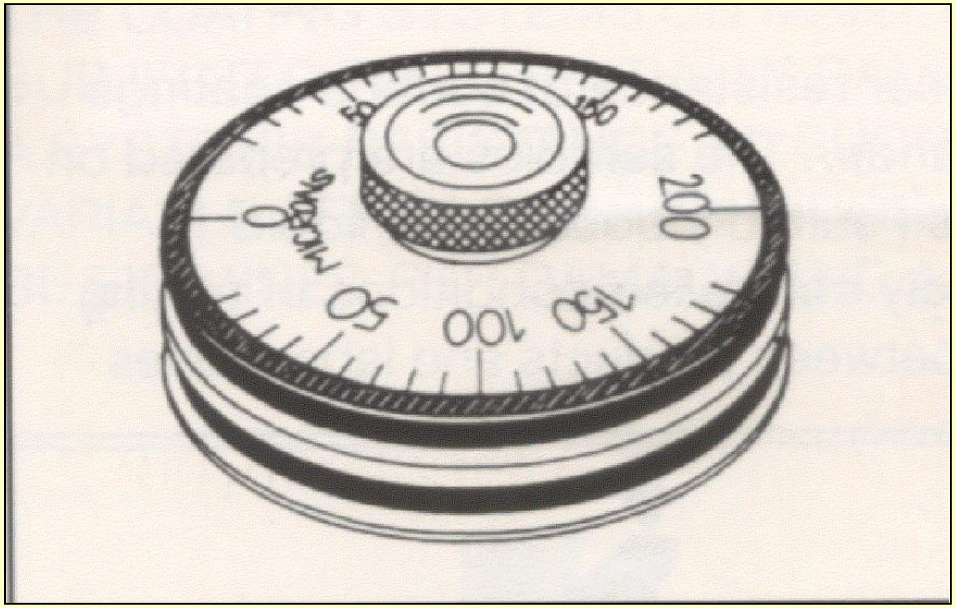
- Involves pressing the paint film with thumb and turning the thumb through an angle of 90 Deg.
- If no loosening, detachment, wrinkling is noticed, the paint is said to be dry through

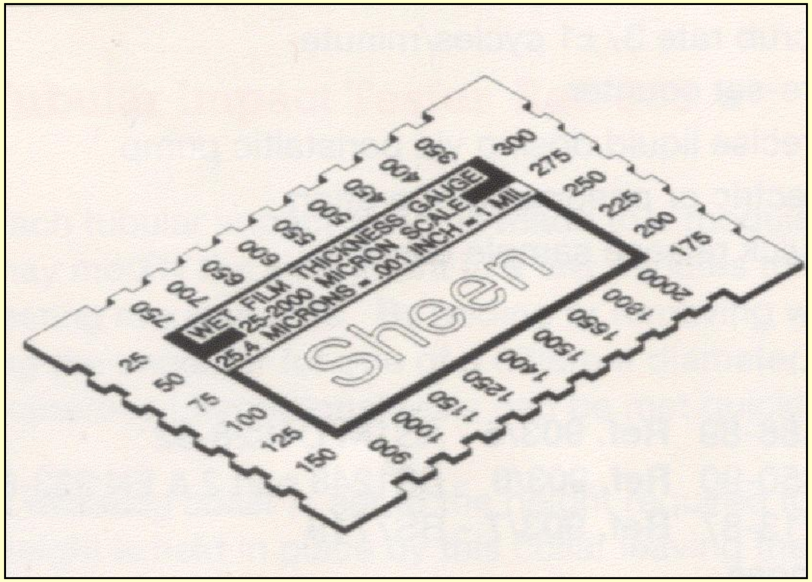
Some other Important Properties

- Sag Resistance
- Dispersion of pigment
- Flash Temperature

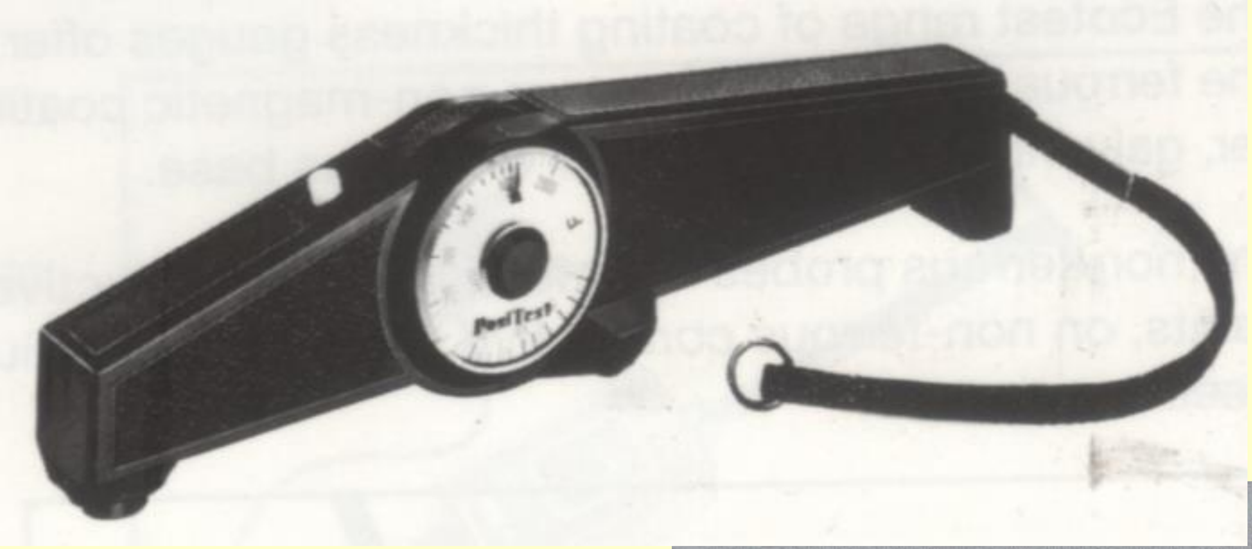
Paint Coating Evaluation

Wet Film Thickness Measurement



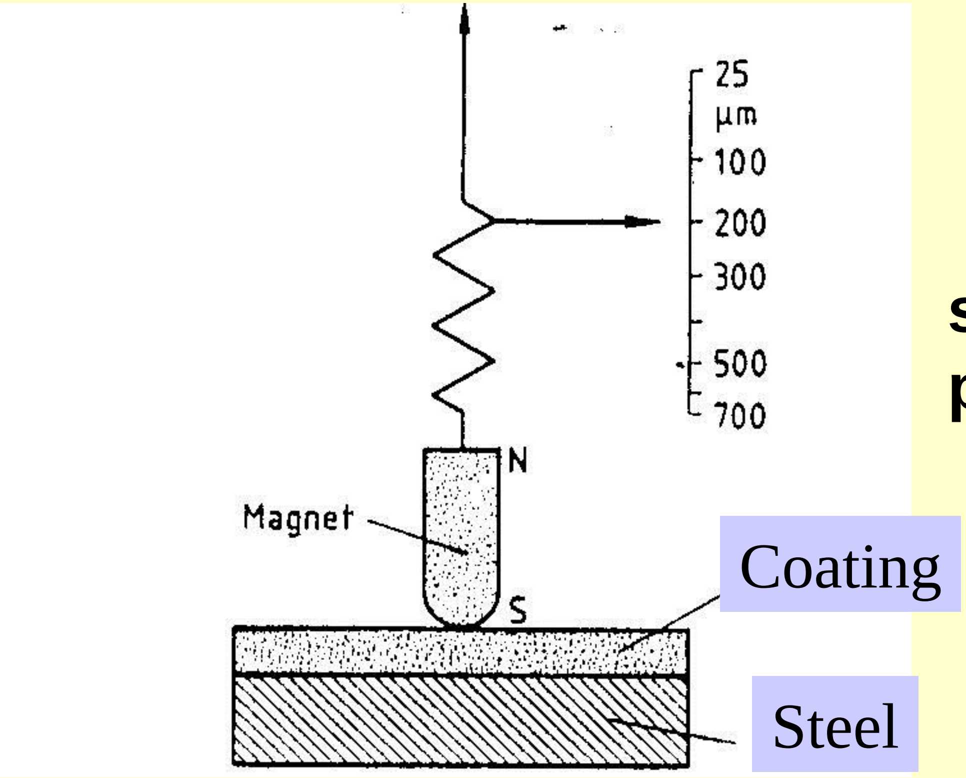


DFT = WFT x % Vol. Solid



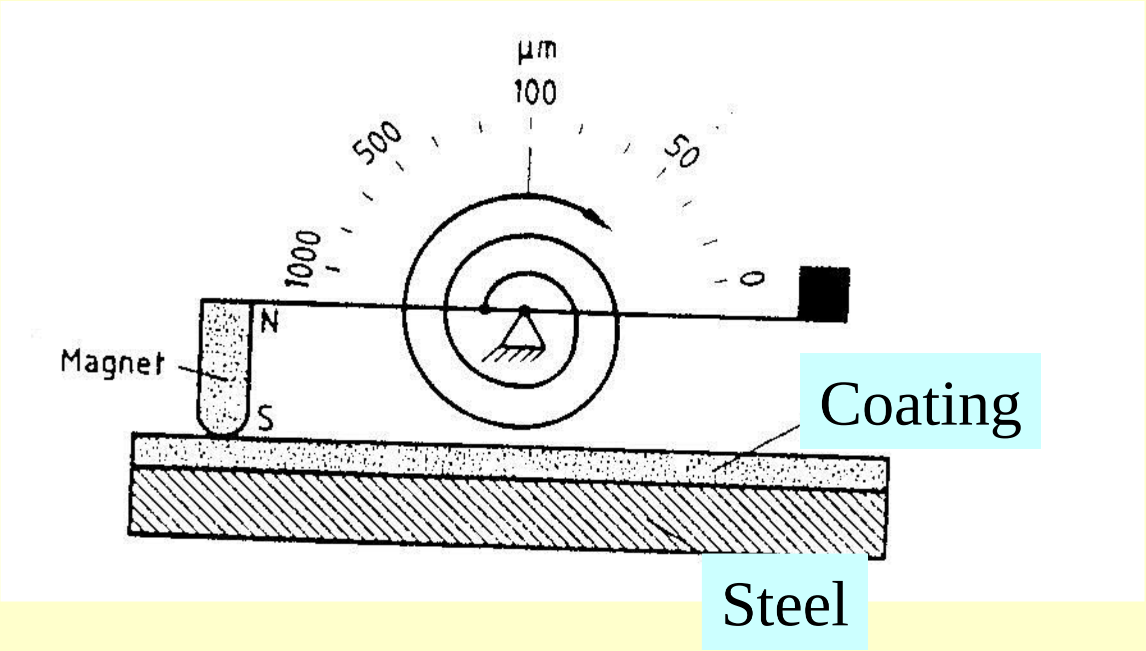
Thickness Measurement

Magnetic adhesion



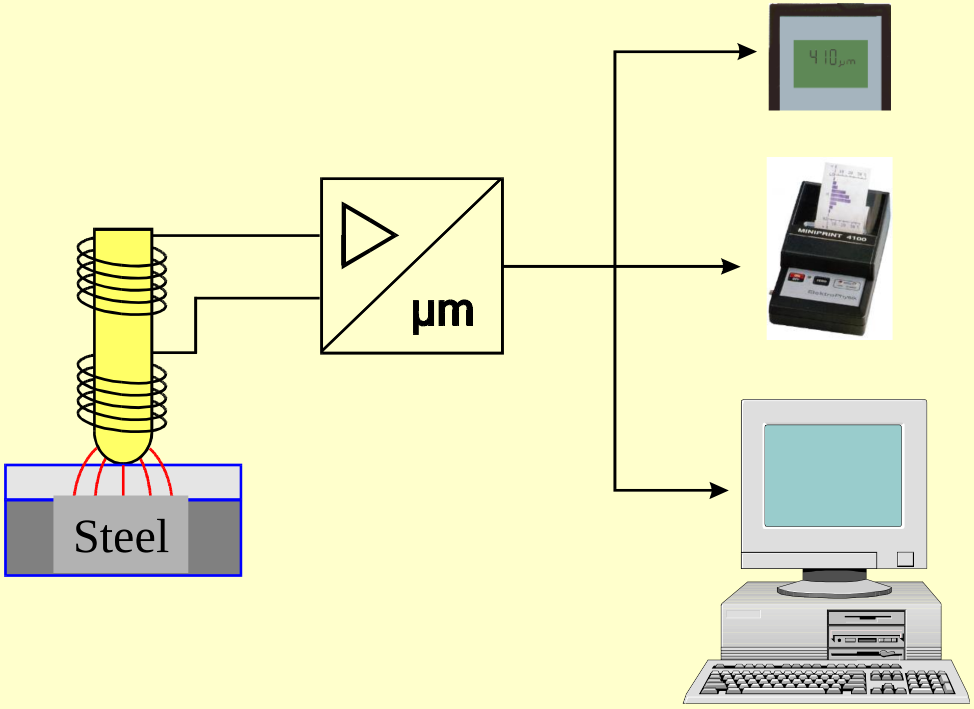
spring balance principle

Magnetic adhesion

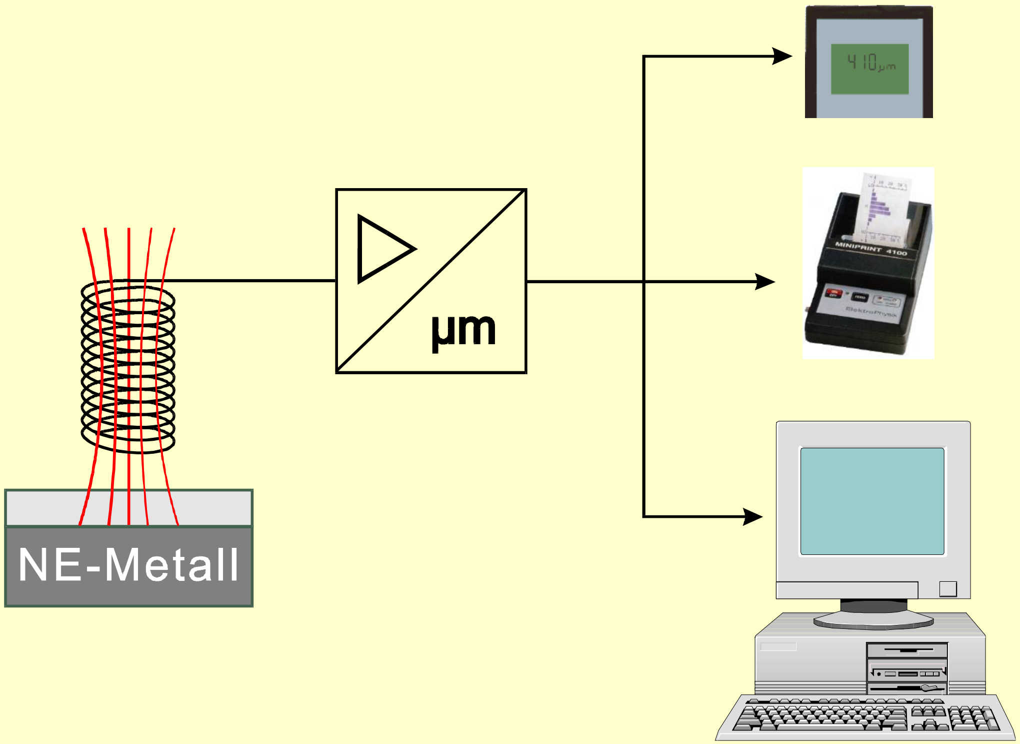


balance beam principle

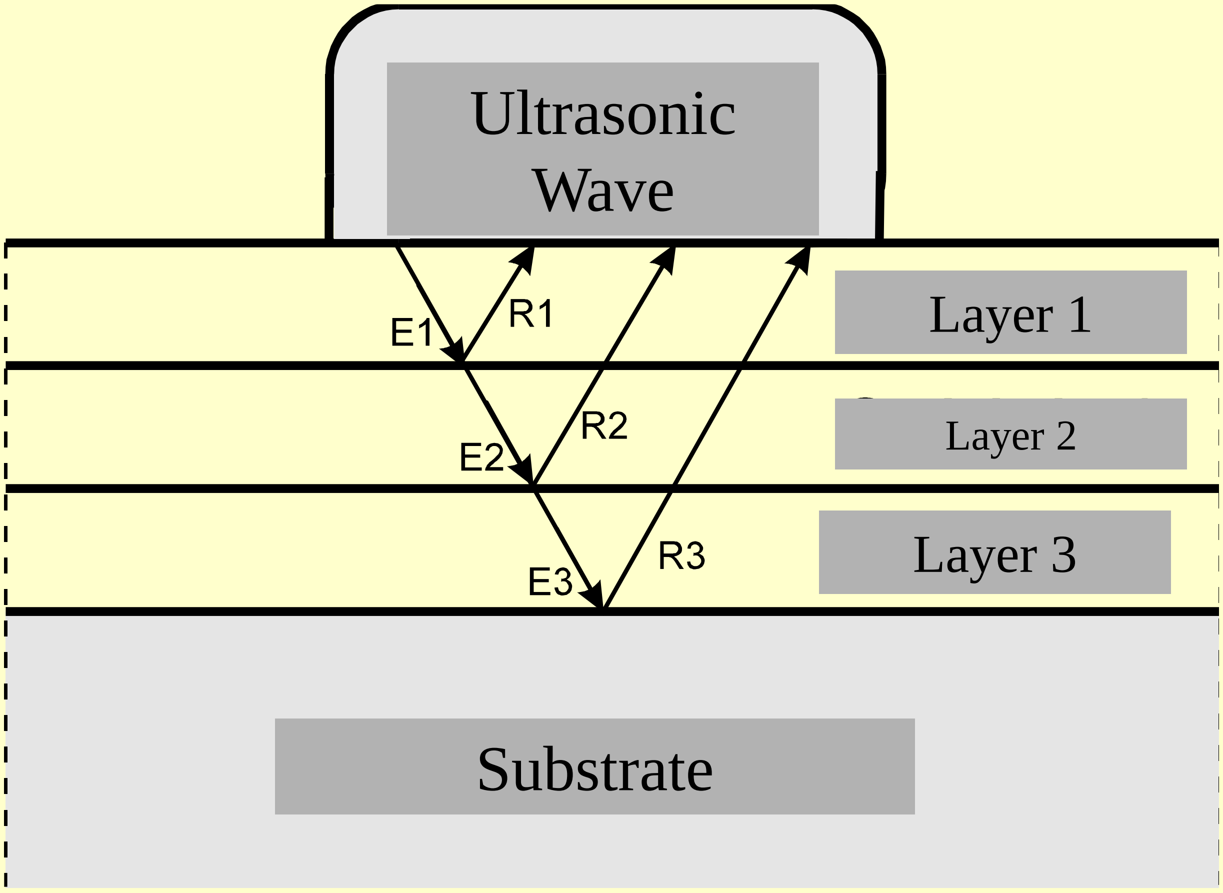
Magnetic induction



Eddy-currents



Ultrasonics principle



MikroTest

- non-magnetic coatings on steel
- Nickel on steel
- Nickel on non-ferrous metals

MiniTest Series

- non-magnetic coatings on iron and steel
- insulating coatings on non-ferrous metals
- non-ferrous metal coatings on insulating substrates

Dual Gauge

Magnetic induction

Eddy-currents

Mechanical Properties of Paint Coatings