DETERMINING ELASTICITY AND STRENGTH CHARACTERISTICS
OF POWDER COATING

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Methods are described for forming coating specimens and testing them in pure bending. The proposed tester gives adequate accuracy in determining the elastic characteristics and strength for thin specimens (up to 0.1 mm) of brittle materials of powder-coating type.

Deformability and strength are decisive in the viability of repaired and strengthened machine components. To estimate coating quality, it is important to examine how the technique used in making a coating affects the deformability and strength. It is therefore important to develop methods and devices for determining elastic characteristics and strength in addition to the methods of making coating specimens.

To establish those characteristics, we use a four-point bending device with calibrated loads. The main feature is that the apparatus can determine these characteristics on specimens separated from the substrate for coatings with various lengths, widths, and thicknesses, which have low rigidity.

To obtain reliable data on the mechanical properties, the thermal and force conditions in the coating specimen formation for test should resemble those for the coating on the workpiece. Therefore, the substrate on which planar coatings are formed for test should have adequate mass and thermal conductivity.

It is very important to be able to separate the deposited coating from the substrate without failure. For that purpose one can use a preliminary layer for example of tin. It is best to examine three specimens in each case for each thickness with identical cross sections, for which we recommend a substrate device (Fig. 1) with removable baffles, which provides for forming three specimens of the same thickness on each side.

The specimen thicknesses are related to the coating thicknesses; the length and width of a specimen, and the mass of the substrate device (in particular the thickness t) are determined by the dimensions of the components on which the coatings are deposited. The substrate material is copper or aluminum, while the baffles may be steel ones. The length of the specimen should be not less than ten times the thickness in order to obtain correct experimental results.

The coating can also be deposited on copper foil, which is then etched away in concentrated nitric acid.

To examine low-rigidity specimens (in particular, thin ones) made of brittle materials the device should be sensitive to stress and strain, which is attained by balancing the lever loading system and by using calibrated loads and a dial gauge with a scale division of 0.001...0.002 mm.

The tester (Fig. 2) consists of a loading suspension bearing calibrated loads, loading levers bearing prisms and balancers, and a table employing knife edges with prisms for loading the specimen together with supports for the dial gauges.

The table 11 with the ties 15 and bearing sleeves 17 for establishing the device in a horizontal position may be mounted on the base 10 by means of triangular slots, in which operate two loading prisms 12 and two intermediate prisms 8. The lower pair of the latter is acted on by two loading levers consisting of the lever rods 5 with gripping screws, the levers 7 themselves with mounted loading prisms 12, and the shafts of the counterweights 6 and the counterweights themselves 4. The impeller 3 acts on the loading levers by means of the two mounted loading prisms 8 and hinged flexible loop 14, to which the calibrated loads 16 are attached during tests.

The measurement unit consists of the dial gauge 1 attached by the clamp 2 onto the stand 13, which bears freely on the entire loading support and is clamped by two screws to the base of the table 10.
The preparation is as follows. The two lower loading prisms are set on the base 10 in the slots symmetrically at a distance apart corresponding to the length of the specimen 9. Then one similarly places in the slots in base 10 the lower intermediate prisms 8 to accommodate the loading levers.

Then a technological specimen (best of the same thickness as the test specimen) is placed on the immobile loading prisms 12, and the rods 5 with levers 7 and counterweights 4 are placed on the immobile intermediate prisms 8. The screws on the rods 5 are released, which provides for some movement of the levers in the guides. The impeller 3 is placed on the levers in such a way that its prisms fall at the bottom of the slots in levers 7. Then the screws are used to fix the positions of the levers relative to the rods 5.

The technological specimen 9 is relieved from the action of the masses of the moving parts of the loading device by moving the counterweight 4 along the shaft 6 to bring about the situation where the levers are in a state of unstable equilibrium, e.g., with a gap between the specimen and the lever prisms constituting a few hundredths of a millimeter. This is readily adjusted with the unaided eye. Then the technological specimen is replaced by the working one and one sets the dial gauge 1 and the clamp 2 and brings the dial gauge to zero (the spring in the dial gauge should be replaced to avoid a marked effect on the deflection of a thin specimen without load).

If the specimen does not have any screw residual deformation and lies without tilt on the loading prisms, it is loaded directly with the calibrated loads and the deflection is recorded. If not, the specimen is preloaded with a load providing normal interaction with the loading prisms.