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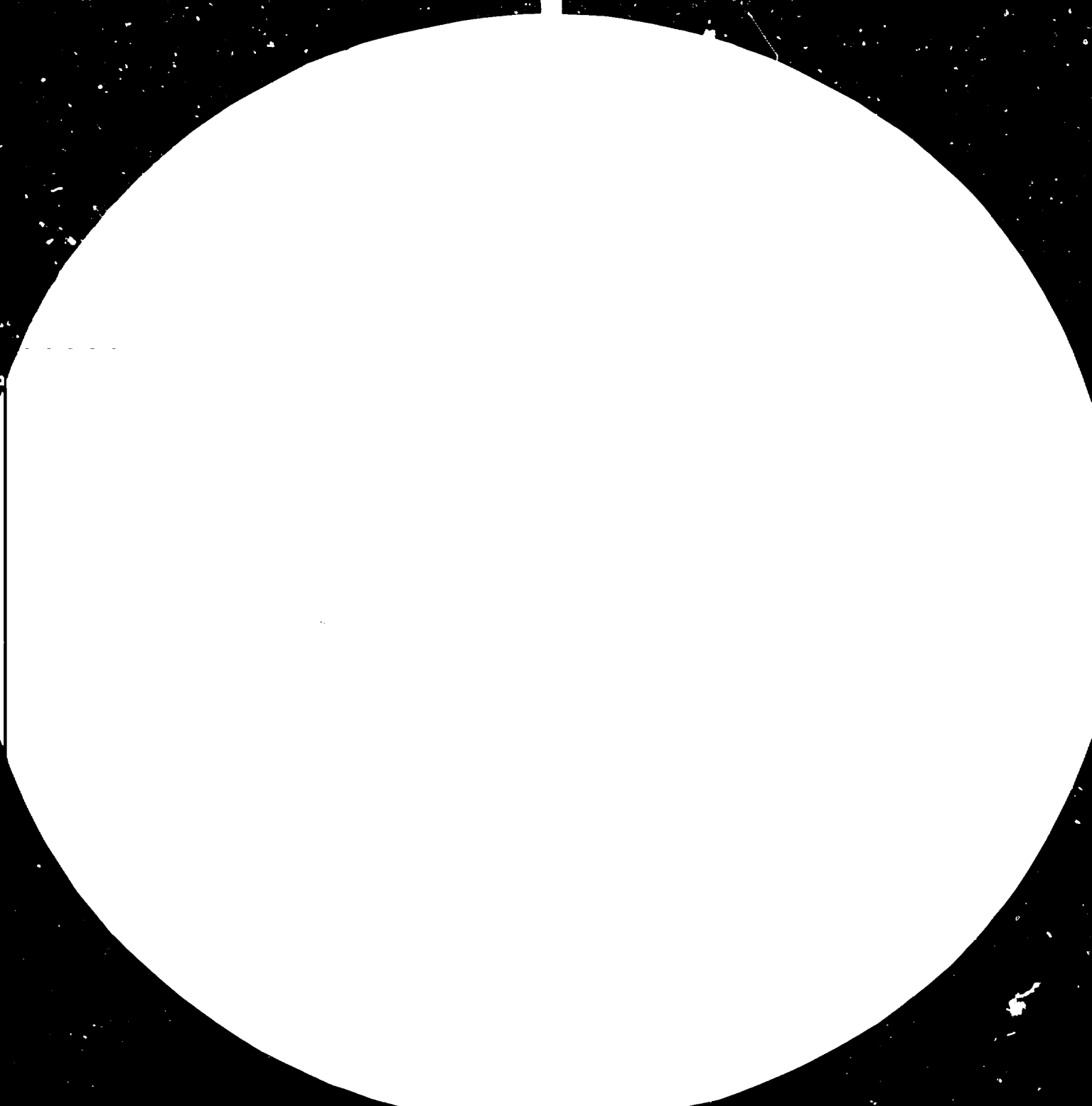

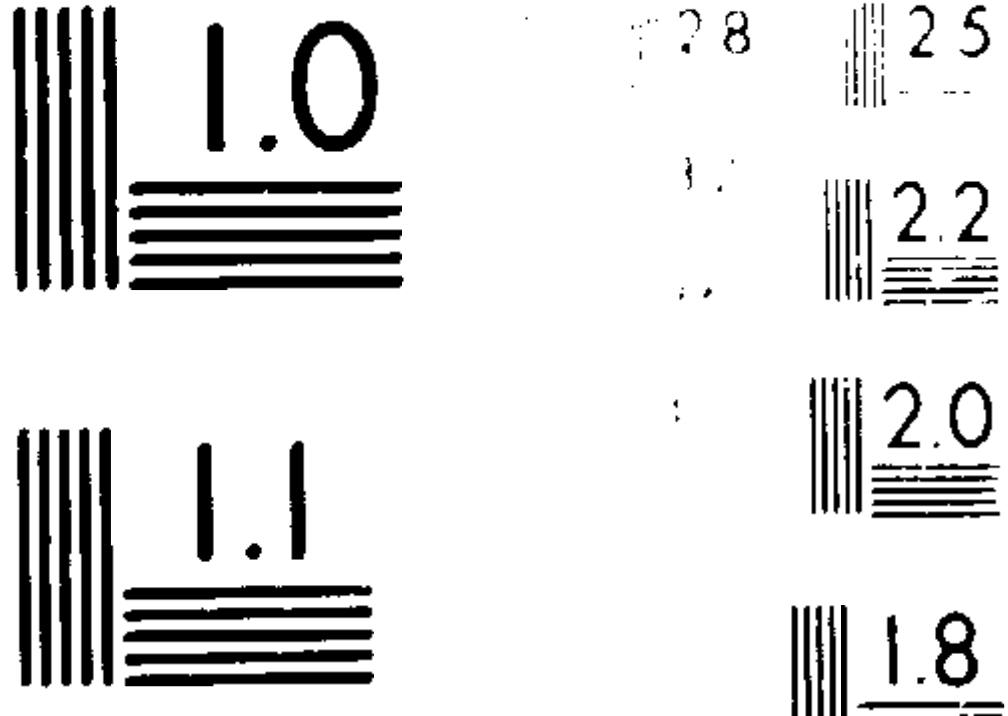
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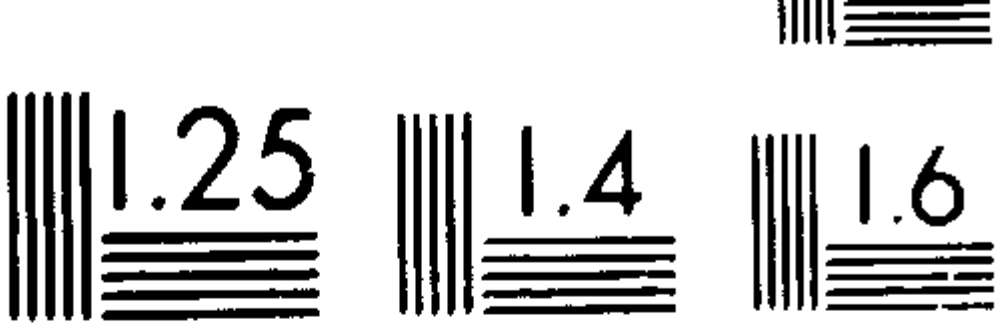
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Distr.
LIMITED
ID/WG.384/12
13 December 1982

ENGLISH

United Nations Industrial Development Organization

Expert Meeting Preparatory to International Forum
on Technological Advances and Development.

Moscow, USSR, 29 November - 3 December 1982

DEVELOPMENT AND APPLICATION OF NEW MATERIALS: A PROSPECTIVE VIEW*

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V.82-34860

Structural materials are used in considerable amounts in all branches of industry, agricultural production, ore mining and processing, new branches of technology. The level of performance characteristics of these materials, the extent of their production and uses determine the rate of progress in the production of the basic means of production and consumer items. Technical progress needs for its implementation machines, systems of machines, process equipment, engineering installations, auxiliary facilities, all of which require appropriate structural materials for their manufacture.

1. General characterization of the structural materials in current use

The tendency which has developed through the long years of industrial progress has been to use the following structural materials (in widely differing amounts, however):

1. inorganic materials for construction purposes (concrete, bricks, mineral blocks, etc.);
2. metallic materials (on the basis of iron, aluminum, copper and titanium, etc.);
3. metal-reinforced structural materials (reinforced concrete);
4. organic structural materials (timber, cordage, natural fibres, etc.);

5. non-metallic materials (various plastics, both hot- and cold-cured, i.e., thermoplastic and thermosetting plastic materials);

6. reinforced composite materials (with nonmetallic reinforcing elements and matrices, with metallic reinforcement elements and nonmetallic matrices);

7. metal- or nonmetal-based composite materials containing inclusions of superhard materials (such as natural or artificial diamonds, etc.);

8. ceramics on different bases for use in chemically active media, at superhigh or superlow temperatures;

9. powdered, amorphous and other metal-based materials.

The first four groups of materials take up as much as 85-95% of the total volume of material consumption, the variance depending on the geographic, resource availability, technological and other features of a particular region or country.

2. Tendencies in the creation and use of structural materials

The development of the leading branches of industry, construction, recovery of useful fossils, power production is accompanied both by absolute and relative increase of the volume of production and consumption of structural materials. In industrially developed countries it is the

new structural materials (Groups 5 to 9 of the above list) which are created and used most intensively.

In the developing countries, owing to the peculiar nature and level of industrial development, the following factors come to the fore:

- mineral and raw material resources and their recovery (in this case inorganic and metallic materials are used to an extent greater than other material types);
- availability of the initial components for creation and production of structural materials (this may boost the production of metallic and composite structural materials);
- natural conditions with tourist-attracting potential (in this case construction materials and structural steels are the most widely used materials);
- severe climatic conditions - high and low temperatures (in this case nonmetallic structural materials are the object of particular interest).

3. Basic requirements to and properties of structural materials

Considering the conditions in which structural material have to work in machines, structures and equipment, the following basic service requirements are imposed on them:

- strength, rigidity and deformability;
- appropriate specific gravity;

- durability under service conditions (temperature, loading cyclicity and duration, corrosion and erosion, exposure to light, etc.);
- performance reliability under varying structural, technological and service factors (stability of the basic physico-mechanical characteristics);
- thermophysical properties (heat conduction and insulation properties);
- electric conductivity and electric resistance;
- thermal deformations;
- damping ability.

To satisfy the set of requirements listed above, a complex of physico-mechanical characteristics are considered, which include: elasticity modulus, yield point, static, long-term static and cyclic strength, plasticity, hardness, wear resistance, corrosion resistance, heat stability, cold stability, specific gravity, static properties, thermal and temperature conduction coefficients, resistivity, internal friction.

The ranges in which each of these characteristics may vary are rather broad for a given material type (from 2-3 times to 50-100 times).

4. Ways of development and use of new structural materials

Whenever one or several of the above requirements are singled out as decisive, special-purpose materials are provided

by ways which may include:

- thermal, thermochemical, thermomechanical and other treatments;
- appropriate surface treatment (surface plastic deformation, tempering, plasma treatment, laser, electron beam irradiation, thermochemical treatment);
- provision of coated and laminated materials (bimetals, polymetals, metals with polymer or other coatings, etc.)
- provision of composite materials (on metal or non-metal base);
- inclusion of superhard materials into softer matrices for mechanical machining tools, drilling and mining applications.

In other cases, multipurpose materials (for example, metallic or nonmetallic) are developed with an optimum complex of the basic properties for wide-scale use in machine building, engineering and construction applications, etc.

As regards the new materials (mentioned in the last groups of the list in section 1), the fields of their application are largely determined by the specifics of their machining or processing (mechanical treatment, plastic forming, moulding, winding, pressing, thermal treatment, etc.), in this case such factors as amount of waste and power requirements for the production of a material or manufacture of an article from it, re-utilizability, environment pollution.

The effect from development and use of a conventional and new material depends on the level and scope of the scientific research, calculation and design as well as the flaw-detection inspections during various stages of manufacture and use of a machine. Where non-conventional materials are concerned, the cost of such research is higher (by 5-20%).

International cooperation is possible and desirable in all the aspects of the problem of structural materials and may be expected to raise the efficiency of developments in each country involved.