
**Metallic powders, excluding powders
for hardmetals — Determination
of compressibility in uniaxial
compression**

*Poudres métalliques, à l'exclusion des poudres pour métaux-durs —
Détermination de la compressibilité sous compression uniaxiale*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

This document was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 2, *Sampling and testing methods for powders (including powders for hardmetals)*.

This fifth edition cancels and replaces the fourth edition (ISO 3927:2011), of which it constitutes a minor revision to adjust punch tolerances in [Figure 2](#) and clarify the use of scale and micrometer.

Metallic powders, excluding powders for hardmetals — Determination of compressibility in uniaxial compression

1 Scope

This document specifies methods for measuring the extent to which a metallic powder is compacted when subjected to uniaxial compressive loading in a confining die under specified conditions.

The method is not applicable to powders for hardmetals.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Symbols

For the purposes of this document, the symbols given in Table 1 apply.

Table 1 — Symbols

Symbol	Designation	Unit
ρ_p	Compressibility ^a	g/cm ³
m	Mass of the compact	g
V	Volume of the compact	cm ³
^a If the compressibility is measured at one pressure only, e.g. 400 N/mm ² , the symbol becomes $\rho_{p(400)}$.		

5 Principle

Uniaxial compaction of a powder in a confining die by double-action pressing. Samples of the powder may be pressed either at a single specified pressure or at a series of specified pressures. After ejection from the die, the density of the compacts is determined.

The density obtained in the former case represents the compressibility of the powder at the specified pressure. The densities obtained in the latter case can be utilized for drawing the compressibility curve of the powder, i.e. a plot of the density as a function of the compacting pressure.

6 Apparatus

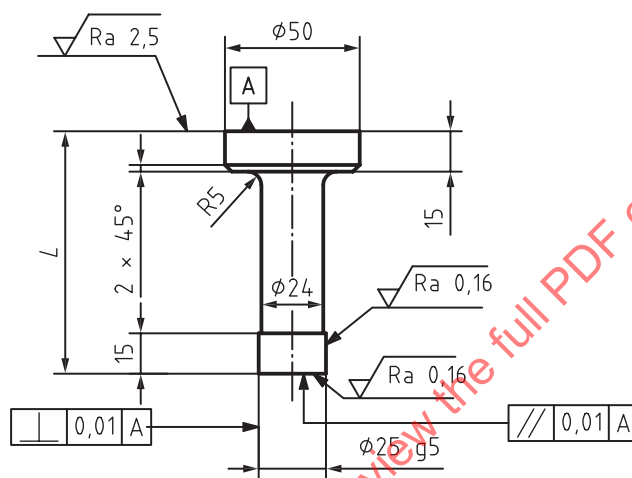
6.1 Die, preferably of cemented carbide, or alternatively of tool steel, and two punches for producing either cylindrical or rectangular compacts.

The cylindrical die should be capable of making compacts of diameter 20 mm to 26 mm with a height to diameter ratio between 0,8 and 1. An example of a design for tooling is shown in [Figure 1](#).

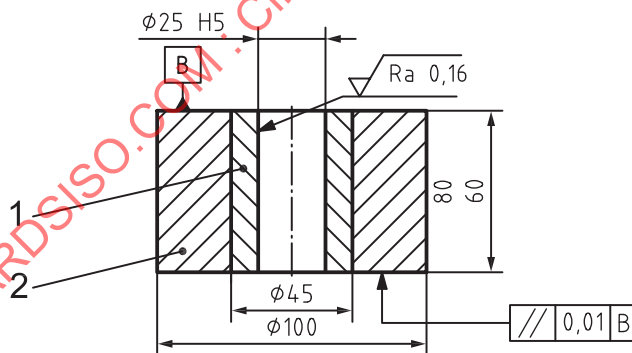
The rectangular die should be capable of making compacts of 30 mm × 12 mm and of thickness 5 mm to 7 mm. An example of a design for tooling is shown in [Figure 2](#).

Mating parts shall be fitted and lapped.

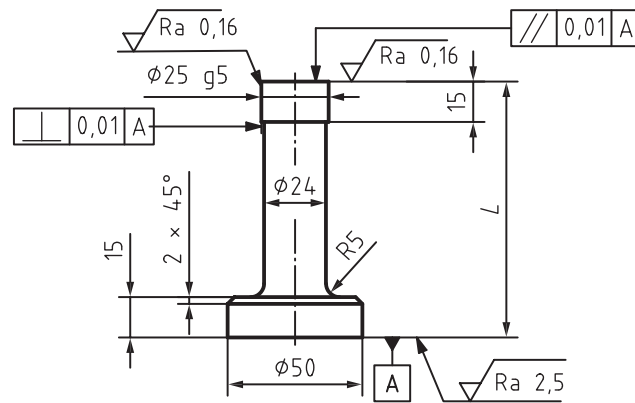
Dimensions in millimetres



a) Upper punch, $L = H - 10$



b) Die, $H = 60 \text{ mm to } 80 \text{ mm}$



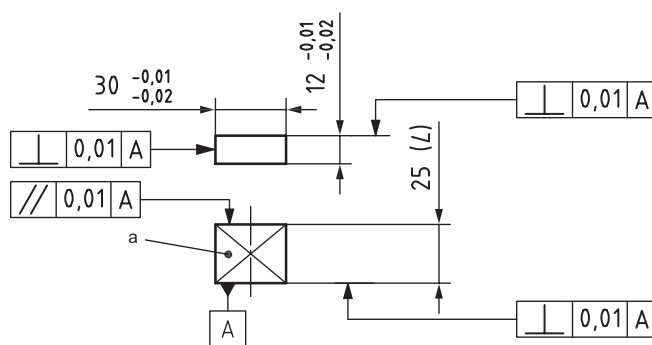
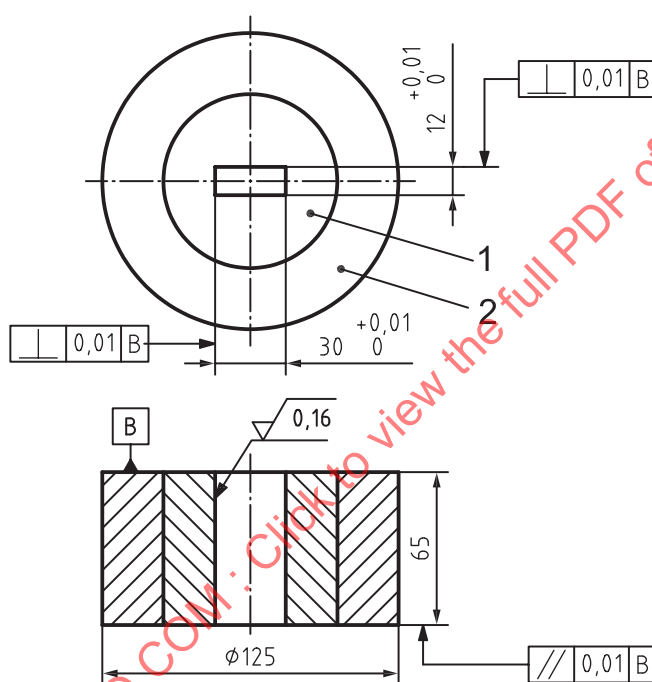
c) Lower punch, $L = H + 35$

Key

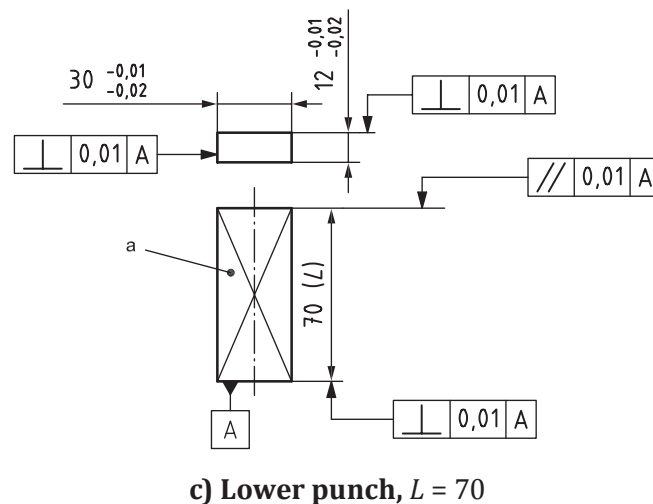
- | | |
|-----|--------------------|
| 1 | cemented carbide |
| 2 | shrink ring |
| H | height of tool die |

Figure 1 — Example of tooling to produce a cylindrical test piece

Dimensions in millimetres

a) Upper punch, $L = 25$ 

b) Die



Key

- 1 cemented carbide
- 2 shrink ring
- a Steel, HRC 60 to 62.

Figure 2 — Example of tooling to produce a rectangular test piece

6.2 Press, capable of applying forces up to approximately 500 kN with a minimum accuracy of $\pm 1\%$ and adjustable to permit an even increase of the force at a rate not higher than 50 kN/s.

6.3 Scale, capable of weighing at least 100 g and readable to 0,001 g.

6.4 Micrometer, or other suitable measuring device readable to 0,005 mm for measuring the dimensions of the compacts.

7 Sampling

The quantity of the test sample shall be chosen to give the required number of test pieces (see [Clause 9](#)) with the dimensions specified in [6.1](#). If necessary, preliminary tests should be made in order to establish the quantity of powder needed for fulfilling this requirement.

8 Procedure

8.1 Cleaning of the die and punches

Wipe the die cavity and the punches with soft and clean paper towelling soaked with an appropriate solvent such as acetone. Allow the solvent to evaporate.

8.2 Powder testing conditions

WARNING — Seizure and excessive die wear may occur, particularly at high compacting pressures.

8.2.1 Powders which do not contain a lubricant can be tested

- a) in a dry die,

- b) in a die with lubricated walls (see [8.3.2](#)), and
- c) after admixing a lubricant (see [8.3.3](#)) and in a dry die.

8.2.2 Powders which contain a lubricant can be tested

- a) in a dry die, and
- b) after admixing additional lubricant (see [8.3.3](#)) and in a dry die.

8.3 Lubrication

8.3.1 General

Use one of the two following methods of lubrication.

8.3.2 Die wall lubrication

Apply to the die walls a mixture or a solution of a lubricant in a volatile organic liquid, e.g. 100 g of zinc stearate in 1 000 cm³ of acetone. After any excess liquid has drained away, allow the solution adhering to the walls to evaporate, leaving a thin layer of lubricant.

8.3.3 Lubrication of powder

Lubricate the powder to be tested by thoroughly mixing into it a quantity (e.g. 0,5 % to 1,5 %) of a suitable solid lubricant (e.g. zinc stearate or synthetic wax).

8.4 Compacting and ejection

Insert the lower punch into the die cavity. Position the die to the desired filling height by using supporting spacers between the die and the foot of the lower punch. Pour the sample into the die cavity, taking the usual precautions to ensure that the powder is uniformly distributed in the die cavity. Position the upper punch and place the die with the punches between the platens of the press. Apply and release a preliminary force of approximately 20 kN. Remove the spacers supporting the die. If the die is supported by springs, or in a similar way, it is not necessary to apply the preliminary force.

Apply the final force at a constant rate that shall not exceed 50 kN/s. Release the force as soon as the predetermined pressure is reached.

Eject the compact from the die by means of the lower punch.

The procedure of compacting and ejection is exemplified in [Figure 3](#).

After ejection and, if necessary, deburring, weigh the compact to the nearest 0,01 g. Measure its dimensions to the nearest 0,01 mm.

8.5 Compacting pressures

For determining the compressibility curve of a powder at a series of pressures, it is recommended that the applied pressures 200 N/mm², 400 N/mm², 500 N/mm², 600 N/mm² and 800 N/mm² be used. If compressibility is to be determined at a single pressure only, it should preferably be measured at one of these pressures or by agreement between the parties concerned.

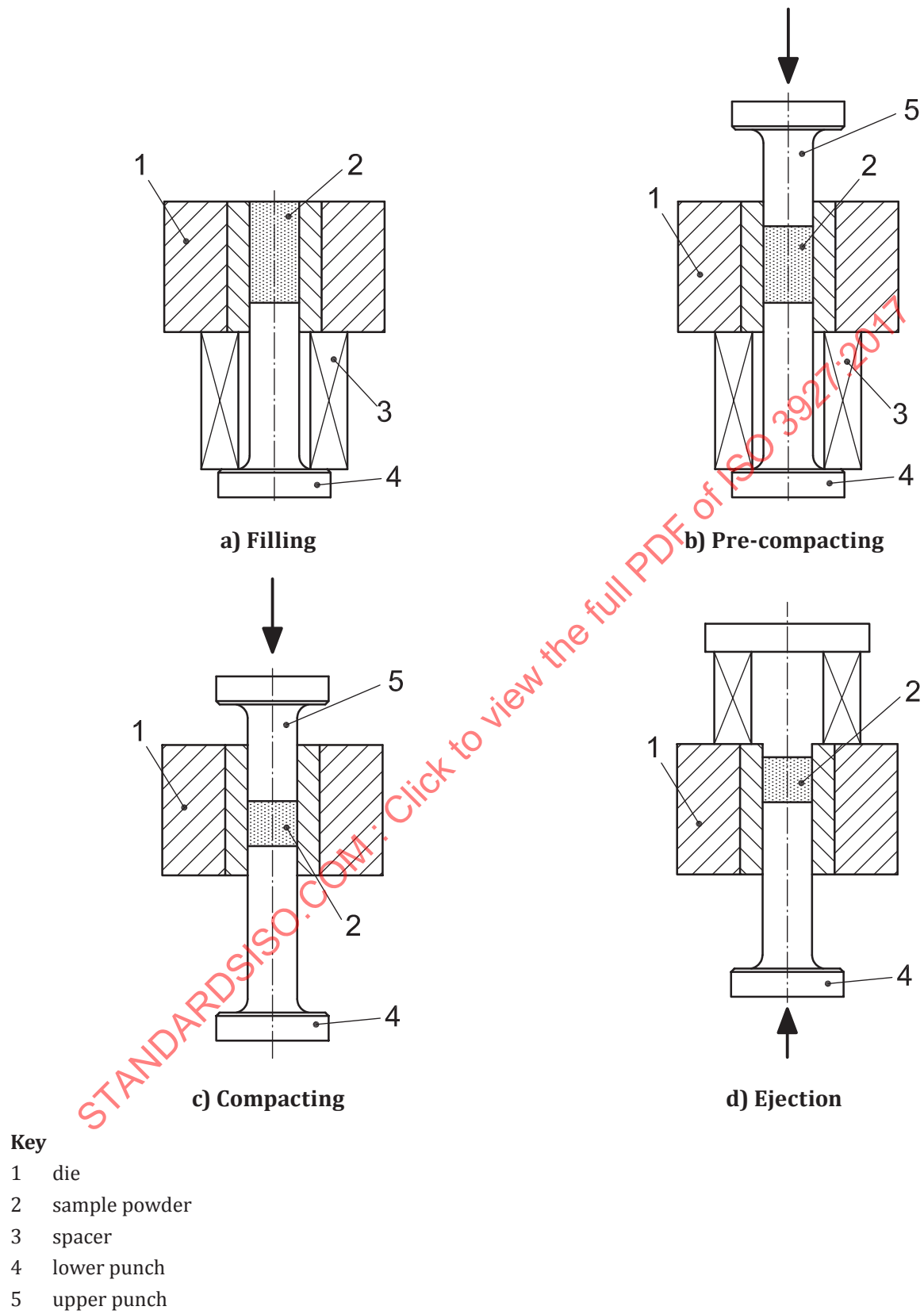


Figure 3 — Procedure of compacting and ejection