

## Description

### Image



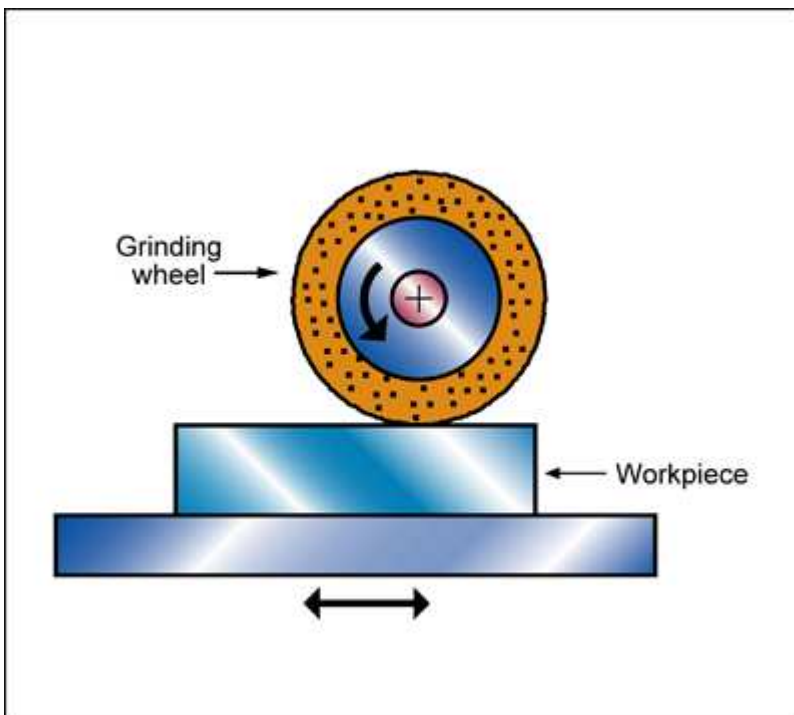
### Image caption

(1) A cylindrical grinder (grinding machine) © Three-quarter-ten at Wikimedia Commons (CC BY-SA 3.0) (2) Man grinding a square tube. © Kleuske at Wikimedia Commons (CC BY-SA 3.0)

### The process

GRINDING includes a group of processes that are used to shape materials that are too hard to be machined by conventional methods, and to improve precision and surface finish. The workpiece is held by a mechanical or magnetic grip that can be tracked or rotated beneath the grinding wheel (if small) or held stationary beneath the moving wheel (if large) while unwanted material is removed using an abrasive grinding wheel. Grinding works best on hard surfaces; soft metals smear and contaminate ("glaze") the wheel. Grinding processes are expensive and should be used only when absolutely necessary.

### Process schematic



### Figure caption

## Grinding

**Material compatibility**

Ceramics	✓
Glasses	✓
Metals - ferrous	✓
Metals - non-ferrous	✓

**Shape**

Circular prismatic	✓
Non-circular prismatic	✓
Solid 3-D	✓
Hollow 3-D	✓

**Economic compatibility**

Relative tooling cost	low
Relative equipment cost	high
Labor intensity	medium
Economic batch size (units)	10 - 1e6

**Physical and quality attributes**

Mass range	0.002 - 1e4 kg
Range of section thickness	1 - 999 mm
Tolerance	0.0127 - 1.6 mm
Roughness	0.2 - 1.6 $\mu\text{m}$
Surface roughness (A=v. smooth)	A

**Process characteristics**

Primary shaping processes	✗
Machining processes	✓
Discrete	✓

**Supporting information****Design guidelines**

Grinding is usually applied to conical, cylindrical, flat or spherical surfaces, but the parabolic or elliptical surfaces (like that of a automobile cam-shaft) can also be ground. Where extreme precision is essential, as in accurate optical systems or in precision machine components, then mechanical grinding and polishing are the only choice.

**Technical notes**

Typical grinding abrasives are silicon carbide, SiC ("carborundum" or "corundum"), or alumina, Al<sub>2</sub>O<sub>3</sub>. Lubricants are used for cooling and to prevent glazing of the abrasive surface. Electro-discharge machining (of metals) can be used to replace grinding.

**Typical uses**

Machinery and structural parts such as pistons, pins, gears, shafts, rivets, valves, pistons, pins, gears, shafts, rivets, valves and pipe fittings, lenses and mirrors for precision optical equipment (ground and polished to a precision of better than 0.1 micron).

**The economics**

The equipment and tooling cost for manual grinding are low (capital cost, \$100 - \$1000; tooling cost \$10 - \$200) but the production rate is low. Those for automated grinding are greater (capital cost \$20,000 - \$1,000,000, tooling \$1000 - \$10,000) but with a higher production rate. Grinding is slow and therefore expensive; over-specification should be avoided.

**The environment**

The hazards depend on the workpiece, its surface coating and the type of abrasive system in place. Dust extraction required for some operations.

**Links**

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MaterialUniverse

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Reference

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