Description

Image

Image caption

(1) A surface grinding machine © Glenn McKechnie at Wikimedia Commons (CC BY 2.5) (2) Camera lenses can be ground and mechanically polished to a precision of better than 0.1 microns. © Sbl0323 at Pixabay [Public domain] (3) Super-thin Mirror Under Test at ESO © ESO at Wikimedia Commons (CC BY 4.0)

The process

MECHANICAL POLISHING is slow and expensive, and should be used only when absolutely necessary. There are many variants, among them: lapping, honing and polishing. All make use of a fine abrasive, suspended in wax, oil or some other fluid, that is rubbed against the surface to be polished by a polishing disk, a belt or a shaped former.

GRINDING is a cruder process, but still one that allows precision in dimensioning and finishing a surface. It works best on hard surfaces; soft surfaces smear and contaminate ('glaze') the grinding wheel.

Process schematic

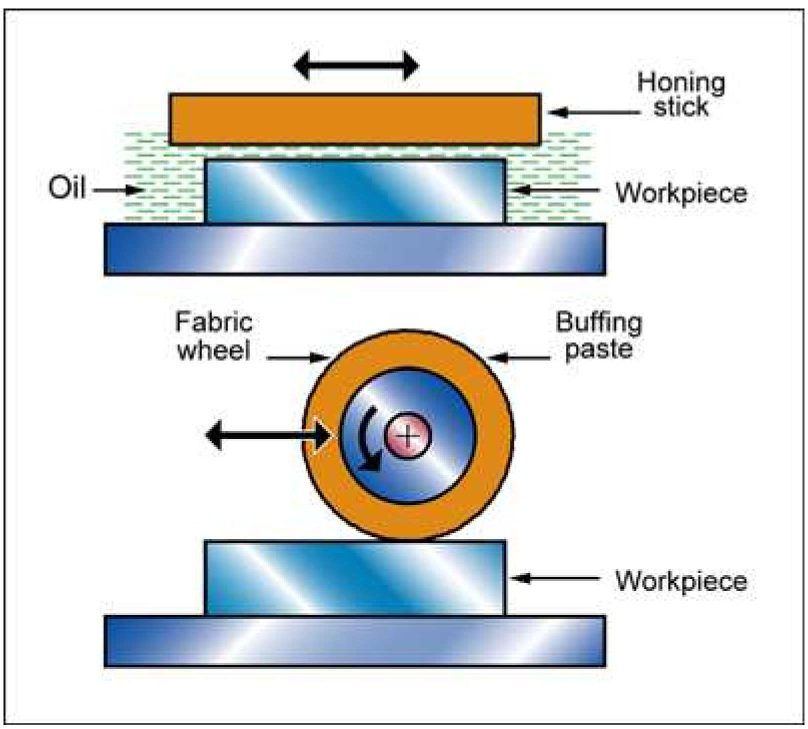

Figure caption

Polishing and grinding

Material compatibility

Ceramics	✓
Composites	✓
Glasses	✓
Metals - ferrous	✓
Metals - non-ferrous	✓
Natural materials	✓
Polymers - thermoplastics	✓
Polymers - thermosets	✓

Function of treatment

Fatigue resistance	✓
Friction control	✓
Decoration	✓
Reflectivity	✓
Surface texture	✓

Economic compatibility

Relative tooling cost	medium
Relative equipment cost	medium
Labor intensity	high

Physical and quality attributes

Roughness	0.00394	-	0.063	mil
Surface roughness (A=v. smooth)	A			
Curved surface coverage	Poor			
Processing temperature	44.3	-	98.3	°F

Process characteristics

Discrete	✓

Supporting information

Design guidelines

Almost any metal or ceramic can be polished using suitable tools and techniques. Polishing is usually applied to conical, cylindrical, flat or spherical surfaces, but the parabolic surface of large mirrors are also polished. There are other ways of polishing - electro-polishing, chemical polishing - that give a highly reflective surface, but if precision is essential, as it is in accurate optical systems, or in precision machine components, then mechanical polishing is the only choice.

Technical notes

Grinding wheels are made of particles of silicon carbide ('carborundum' or 'corundum') bonded in a cement or polymer binder. Lubricants are used for cooling and to prevent glazing. Polishing uses rotating wheels or belts and abrasives with or without lubricants. Less material is removed than with grinding and it produces a smoother surface. Polishing can be divided into four steps: roughening, greasing, buffing, color buffing. From the roughing step to the coloring step finer and softer abrasives are used and the pressure is reduced. The polishing compound can be in the form of a solid bar or liquid. While solid compounds always are used in manual operations, liquid compound is most advantageous when used on automatic machines: production time is increased, as no time is needed to change the bars or sticks.

Typical uses

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 polishing are low (capital cost, \$100 - \$1000; tooling cost \$10 - \$200) but the production rate is low. Those for automatic polishing are greater (capital cost \$20,000 - \$1,000,000, tooling \$1000 - \$10,000) but with a higher production rate. Mechanical polishing is expensive; over-specification should be

The environment

Hazards depend on the specific operation, the workpiece, its surface coating and type of abrasive system in use, but are not severe.

Links

MaterialUniverse

Reference