

MEASUREMENT OF SURFACE TEMPERATURES OF TOOLS AT CUTTING SPEEDS OF 1-800 m/sec

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Cutting speeds of hundreds of m/sec have become commonly used only in recent years. The temperature at the contact between the materials is one of the main factors governing the wear of the tool. Several measurements have been reported [1-3] on contact temperatures in friction and grinding, but these results cannot be transferred to cutting, because the normal load in that case may be hundreds of kg, with contact times of only 10^{-2} to 10^{-5} sec.

Kronenberg [4] has measured the temperature at the rear face of the tool with an inserted thermocouple; the rise was found to be small, but the results were considered only as preliminary.

We have measured cutting temperatures for various metals at surface speeds of 1-800 m/sec, the detector being the natural couple provided by two tools of identical shape and operating conditions made of R18 high-speed steel and T15K6 hard alloy, these being insulated one from the other. The tools are connected through the material during the cutting time (usually 10^{-4} to 10^{-5} sec), and the temperatures at the contacts (taken as the same for both) produce a potential difference at the cold ends.

The metals were zinc, aluminum, brass, copper, and steel 3, which were driven at speeds up to 100 m/sec with a motor; the range 100-800 m/sec was covered by shooting cylinders from a gun. The output pulse was amplified and recorded by an oscilloscope, which was calibrated with pulses of known height, as in [3].

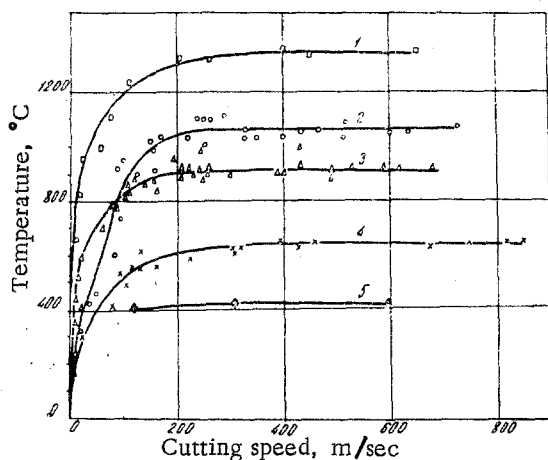


Fig. 1. Contact temperature as a function of temperature for: 1) steel, 2) copper, 3) brass, 4) aluminum, 5) zinc.

Figure 1 shows the contact temperature as a function of speed for these metals. There is a more or less rapid rise to the melting point of the more fusible metal of the pair, which thereafter remains unaltered. There was no marked relation of temperature to depth of cut.

The melting point of the steel (about 1500°C) is above that of R18 high-speed steel (about 1300°C), so the hard alloy should give a contact temperature of about 1500°C and the R18 about 1300°C ; the over-all voltage thus corresponds to a temperature in this range, as Fig. 1 shows.

Bowden and Persson [2] found no surface melting because the thickness of the melted parts was too small to be readily observed by metallographic methods. Low temperatures were found in [4] because the measurements were made at some distance from the cutting edge.

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DIELECTRIC CONSTANT OF SINGLE CRYSTALS OF LITHIUM HYDRIDE

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The literature carries no evidence on the dielectric constant ϵ of LiH crystals, which is needed in order to estimate the wavelength λ of the proper modes of the lattice.

We have made measurements on transparent crystals of average size $8 \times 4 \times 1$ mm, which rapidly become blue on exposure to the light. Spectral analysis (see table) was used to evaluate the purity, as was the density (measured by weighing in a liquid), which was 0.78 g/cm^3 . These results indicate that the LiH was reasonably pure.

Type IIEV-1 capacitors [1] were used at 500 kc and 23°C to measure ϵ , which was found as 10.5 ± 0.26 .

Measurements on ϵ were also made for single crystals of ZnS and LiF, which gave 8.15 ± 0.15 and 9.1 ± 0.1 , which agree well with published values [2, 3].

The wavelength λ of the proper mode of LiH is given by Born's formula [3]: $\epsilon = \epsilon_\infty + 2.95 \cdot 10^6 (\rho \cdot \lambda^2 / M_1 \cdot M_2) \times (e^*/e)^2$, $\epsilon_\infty = n^2$, n is the refractive index of LiH, ρ is density, M_1 and M_2 are the atomic weights of Li and H, and e^* is the effective charge on the ion; n is given [4] as 1.9, while e^*/e was taken [5, 6].

The formula gives $\lambda = 56.5 \times 10^{-4} \text{ cm}$.

Impurity Contents of LiH

Impurity	Mg	Sn	Mn	Ba	Si	Fe	Cu	Al	Ca	Na
Conc, %	0,01	0,17	—	—	0,15	0,14	0,003	0,009	0,0001	0,023

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THE SCALAR APPROXIMATION IN THE SCATTERING OF A PLANE LIGHT WAVE BY A SPHERE

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This approximation is obtained by replacing the solution to Maxwell's equations for monochromatic waves by the solution to Helmholtz's equation. Here I consider the limits to the applicability of that approximation for this problem (problem I) and illustrate one aspect of the approximation (a mathematically simpler means of finding a certain approximate solution). The above replacement has been discussed before [1-3] as regards the meaning of the scalar perturbation appearing in the theory of optical diffraction, but the question of the formulation of the boundary conditions has remained open.

It is usual to seek the solution to Helmholtz's equation for a sphere subject to the following boundary conditions at the surface of the sphere of radius r (problem II):

$$\psi + \varphi = W, P_0 \frac{\partial}{\partial r} (r\psi + r\varphi) = P_1 \frac{\partial}{\partial r} (rW),$$

in which φ , ψ , and W are functions describing the incident, external, and internal waves; φ represents a plane wave, while P_0 and P_1 are constants.

The exact solutions to problems I and II show that for small scattering angles (i. e., for directions differing only slightly from that of the incident wave) the solution to I may be put as $1/2$ of the sum of the solutions to II with $P_0 = P_1 = 1$ and $P_0 = 1/P_1 = m$ (m being the relative complex refractive index of the sphere) without the spherically symmetrical s -waves. The first solution corresponds to the electric vibrations and the second to the magnetic ones.

Approximate solutions to II may be derived from the results of [4], in which it is shown that for small scattering angles and $kr \gg 1$ (k is wave number)