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THE INFLUENCE OF THIN SURFACE LAYERS OF MINERAL OILS ON THE DAMPING CAPACITY OF METAL SAMPLES

W. Chomka and E. Denga

Institute of Physics, Technical University of Gdańsk, 80-952 Gdańsk, Poland.

Abstract.—Low temperature peak on the internal friction curve for CoPt samples covered with the layer of mineral paraffin oils was found to be connected with the nature of surface layer. The temperature position of the peak is related to the melting point of the solidified oil and its height depends on the annealing temperature.

1. Introduction.—Internal friction peaks are mainly connected with bulk effects but it is also known that artefact peaks appear when the atmosphere surrounding the sample is not perfectly controlled or its surface is not sufficiently cleaned. In the samples of different metals and alloys covered with a thin layer of mineral oil the complex spectrum of internal friction at the temperature range 160 to 300 K was first observed in works [1,2].

For better understanding of this phenomenon the present paper describes the effect of thin layer of different paraffin oils on the internal friction of CoPt alloy samples.

2. Experiment.—The temperature dependence of internal friction and decay of observed spectrum with increasing annealing temperature was measured for equiatomic CoPt alloy sample covered with different paraffin oils and hydrocarbon C16H34. The CoPt alloy was in ordered state with a low background of internal friction. The samples had a form of wire about 60 mm in length and 1 mm diameter. Measurements were performed with a torsion pendulum oscillating at 0.5 to 2.0 Hz. The heating rate of the samples was about 2 to 3 K/min.

The oil layer was put on by lubricating but similar internal friction spectra were obtained with samples quenched into the oil or just immersed. Approximate calculations of layer thickness was possible by determining the sample weight before and after coating. The layers thicknesses were estimated as 2 to 6 μm.

3. Results and discussion.—After covering the sample with a thin layer of mineral oil or hydrocarbon an asymmetric peak with an associated modulus defect appears. Fig.1 shows the results of internal friction measurements, Q⁻¹/T, for four CoPt samples covered with
paraffin oils for vacuum diffusion pump /1/, /3/, vacuum rotary pump /2/ and with hydrocarbon $C_{16}H_{34}$ /4/ as well as for CoPt sample without any oil layer. Fig. 1 also shows the typical frequency changes $f^2/T$ is proportional to shear modulus $G$ determined for sample with $C_{16}H_{34}$.

![Graph](image)

Fig. 1: The temperature dependence of internal friction for CoPt samples covered with a thin layer of: 1, 3 - oils for vacuum diffusion pumps, 2 - oil for rotary pump, 4 - hydrocarbon $C_{16}H_{34}$, 5 - background. Upper side: temperature dependence of vibration frequency for CoPt sample covered with $C_{16}H_{34}$.

The great difference is seen between the curve for clean sample and for sample with a surface layer. On each experimental curve the
distinct peaks appear at temperatures /T_n/ about 210, 230, 235 and 280 K respectively, depending upon the kind of applied oil. The peak height also changes with the kind of oil.

Fig. 2 shows the changes of a peak height /Q^{-1}_{max}/ as a function of annealing temperature /T_a/.

![Graph showing peak height as a function of annealing temperature](image)

**Fig. 2:** Peak height as a function of annealing temperature for CoPt sample covered with C_{16}H_{34}.

Annealing time at each temperature was about 20 min, and after cooling the sample to about 150 K the internal friction was measured. The most intensive changes of peak height start at about 330 K. Peak annulcals out after heating at the temperature T_g \sim 500 K. T_m and T_g appear to be respectively the melting temperature and decomposition temperature of tested oil at the lowered pressure.

Thus the nature of the internal friction peak should be attributed to the surface layer properties and not only to the base properties. However the observed internal friction spectrum and changes of shear modulus are the resultant of the processes occurring in the surface layer as well as in the bulk. After appropriate calculations...
one can separate these two processes in the way similar to that proposed in [3] for metal - glass composite.

4. Conclusions.- 1/ Low temperature internal friction spectrum for the samples covered with the layer of oil for vacuum pumps shows the distinct peaks at the melting temperature of solidified oil. 2/ The great deal must be taken for cleaning the specimen studied with internal friction especially in experiments involving irradiation or quenching. 3/ The new method is opened for studying the mechanical properties of different kind of solidified layer of oils and their mixtures.

References