16. ADHESIVE TAPE

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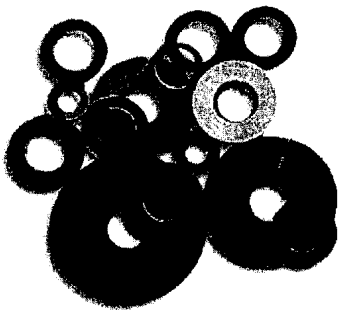


Fig1.Different adhesive tapes

So, let us at first determine what is adhesive tape? Adhesive tape – is tape, which consist of thin dielectric tape, with glue on one or both surfaces of this tape. This glue is non drying and has ability to adhere to a surface by van der Waals's forces. Such adhesive tapes are widespread: for example scotch (diaphanous adhesive tape) or insulation tape.

Now, when we know, what is adhesive tape, we can consider the main questions of the problem. In the text of the problem there is a remark that surface must be flat. We think that surface must be smooth to get more big area of contact with tape.

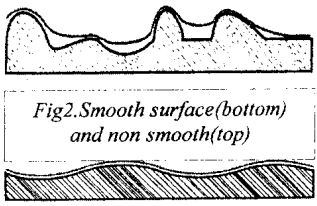


Fig2.Smooth surface(bottom) and non smooth(top)

At first we decided to determine, whether is it possible to observe by an eye the light produced by ripping, and by which tape can be got maximum effect. As flat surface we used fiberglass. During the experiment we glued adhesive tape on the fiberglass and after some time ripped it in the dark. By this we determined that the most bright light can by got by ripping of scotch. By this can be observe a weak blue light. This effect is called Deriagin-Krotova's effect and is investigated rather small, but it is known that it has electric nature.

Fig3.The ripping

We decided to make photo of this phenomenon. For this we glued scotch directly to the emulsive layer of photo tape Kodak Gold 400 and ripped it. You can now see the result of our experiments (see color appendix). On these photos you can see a blue places –this is the light we were interested. To proof that this is light, and not some another radiation, which could act on the film, we ripped scotch from glass, under which a photo film was placed. Glass passes only light, and adsorbs other kinds of radiation (see color appendix). Blue spots on the photos are darker, because the distance between scotch and film was enlarged. Also we discerned that light's brightness enlarges with the speed of ripping. It is very difficult to measure brightness with some apparatus, because the light is very weak and very transient. To determine approximate dependence on velocity we ripped scotch with different speed from emulsive layer of photo film Konica Centuria 800. On these photos you can see that with increasing of the speed enlarges also brightness (see color appendix).

Let us find explanation for this phenomenon. It will be better to begin solving of the problem from scotch glue's composition and it's properties. It is very difficult to determine chemical formula of the scotch's glue, but it is known, that a glue, used in adhesive tapes, is a

liquid high-molecular polymer, which molecules are electric dipoles with big dipole moment. By the contact of such a glue with surface an adsorption takes place. Adsorption – is property of surface of solid bodies or liquids to connect molecules of other matter that is in liquid or aeriform condition, which is in contact with surface. In this process molecules of adsorbing matter are orienteering in one direction. As I mentioned molecules of glue are electric dipoles, and when they are polarized the double electric layer with strain about 10^8 V/m appears. Under the action of electrostatic field redistribution happens of electrons between glue and surface in the way to compensate this field.

So what will happen by the ripping? If we pulled glue from the surface, on some distance adsorption will disappear. As the result, the molecules, polarized earlier, are going to random positions, and double electric layer disappears. But there are redistributed electrons, which are also creating electrostatic field. Hereinafter the pulling can be considered like recession of flat capacitor's plates. By the increasing of a distance, potentials difference between glue and surface increases, until discharge happens. The existence of discharges can be proofed by the following experiment. We dust the plexiglass, from which scotch was ripped, by two component powder. Components must have different color and charge. By this we can see well known Lihtemberg's figures. You can see the results of our experiments now. We used mixture of the printer's HP5L toner powder (it is black) with powder of canella (it is yellow). By the mixing, toner takes positive charge and canella – negative (see color appendix). On these pictures we can see zones, in which discharge happened. Now it is possible to determine the reason of light intensity dependence on the speed. During the pulling efflux of charge happens, and as time of ripping is more, then bigger is lose of charge, so energy, which is spend on the discharge, decreases.

Also process of light liberating by the discharge is interesting. By the ripping, as I already mentioned, enlarging of the potential's difference happens. And if potential is enough for discharge, so if

$$A = eEd$$

then electrons, which are flying out from the glue and surface, under action of electrostatic field are taking energy, that is enough for ionization of gases in the air. Air consist of 21% of oxygen and 78% nitrogen. During the discharge oxygen liberates light with wave length 435 nm (12,6 eV), and nitrogen – with wave length 410 nm (13,6 eV) and 415 nm (13,3 eV). All these values of wave length's are in blue sector of visible spectrum, what is corresponding to the light observed.

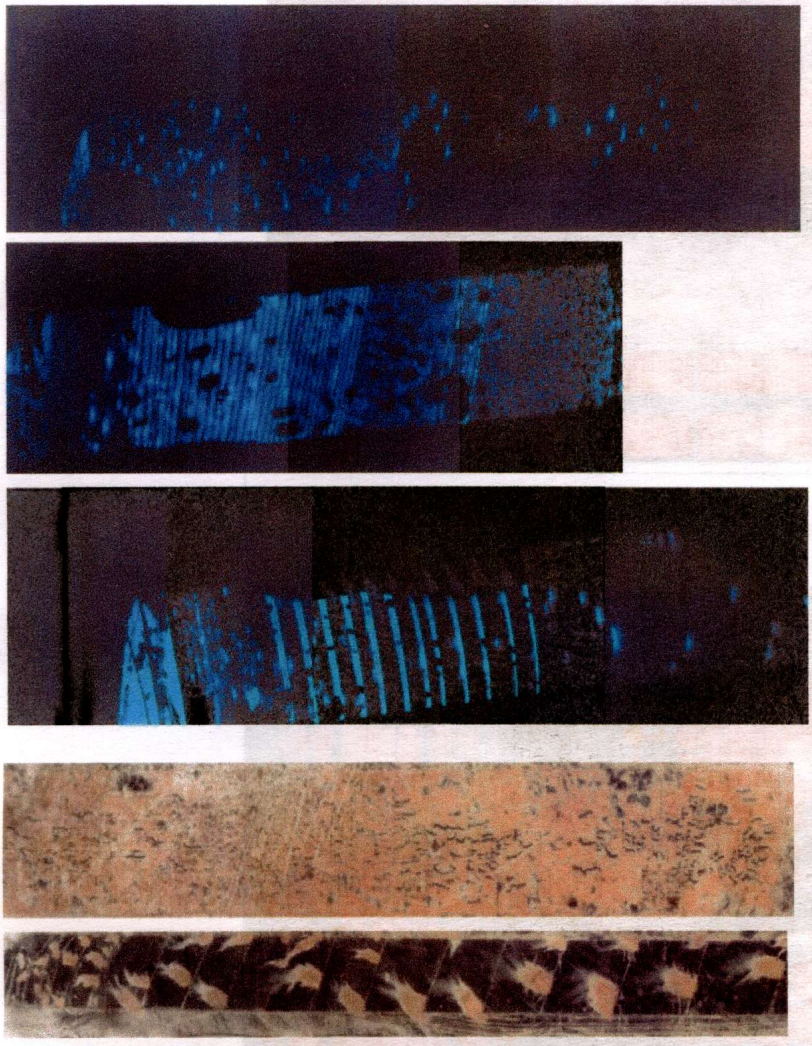
So as result of my report I want to remind the question of the problem. The is written: investigate and explain the light produced by ripping. Unfortunately, because the light is very weak and very transient, we could not quantitatively measure intensity of light, and also it's dependence on external parameters: such as external pressure, humidity and other, but we investigated the light by the photos and explained using Lihtemberg's pictures and photos.

Acknowledgements:

Special thanks to my friend Goga Ayropetov, who was also worked on the solving of this problem.

Reference:

Krotova N.A. About Gluing an adhering, Moscow 1960



Dependence of the light's brightness on the speed(top three photos),
And Lihtemberg's pictures(bottom)