acta physica slovaca vol. 46 No. 5, 667 – 670 October 1996

A METHOD OF MEASURING THE CONDUCTIVITY OF AIR-SENSITIVE SUBSTANCES IN DEPENDENCE ON PRESSURE (ALKALI METAL ANTHRACENE ADDITION COMPOUNDS)

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Received 16 July 1996 , accepted 26 July 1996

The conductivity of alkali metal anthracene addition compounds of the general formula M_x(atc) with $x = 2.0$ and $= 1.5$ was measured in dependence on pressure up to 400 MPa, showing values in the range of 10^{-8} S/cm. A suitable apparatus is described.

1. Introduction

The electrical conductivity of alkali metal anthracene addition compounds, shortly aducts, showing a semi-conducting behaviour according to Ubbelohde [1,2] is of theoretical and practical interest as well,as they are supposed to play a role in the lithium-iodine battery by transferring anodic lithium to poly-2-vinylpyridine used as coating materials [3]. In the literature there are only values for non-stoichiometric compounds and the pressure applied was not very high (some results have been summarized in [4]). In this paper we present the solvent-free di-metal adducts of anthracene which are highly sensitive to air and moisture.

2. Experimental

Preparation of the adducts that we have investigated, Li_2(atc), $Na_{1.5}$(atc), Na_2(atc) (atc=anthracene), has already been described elsewhere [5,6].

For performing measurements of the conductivity in dependence on pressure under anaerobic conditions, a special cell has been constructed (Fig. 1.). It consists in principle of an anvil 1 a piston 2, both made of steel and placed into a tube 3 made of poly-metacrylate. In tis way both the parts are electrically insulated. To guarantee a high resistance to pressure, the tube is coated by a metal jacket 4. Jacket and piston are provided by a ring 5, mounted at the top in both the cases, the distant of which can be measured by a micrometer screw at different places of the rings,being equivalent to the thickness of the sample. At the bottom part of the anvil and the top part of the

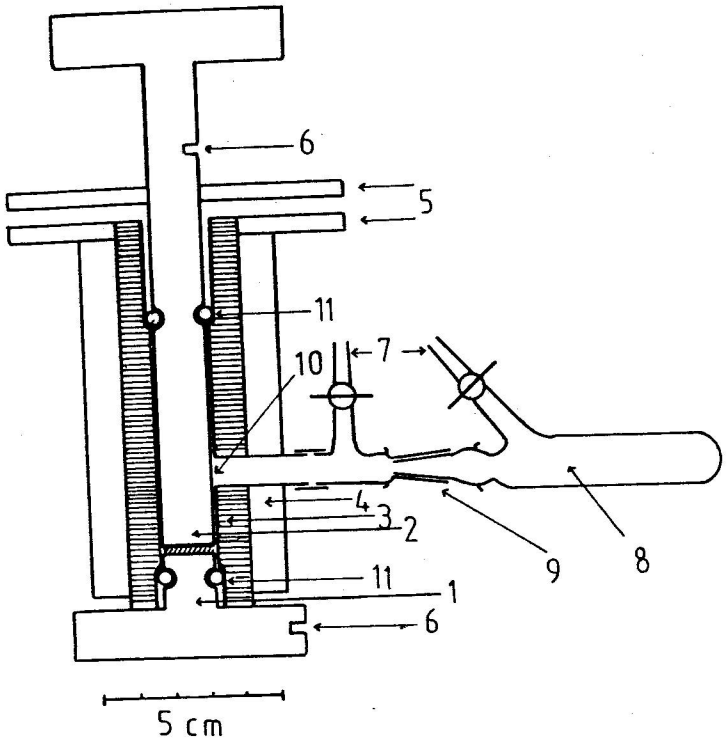

Fig.1. Cell for measuring the conductivity of air-sensitive substances in dependence on pressure under inert conditions. Designation: see text.

piston there are sockets 6 for applying the voltage. The pressure is made by an optional oil press. For determining the specific conductivity, a direct-current voltage of 2 V was applied and the current (being in the range of 10^{-7} to 10^{-10} A) was measured by a highly sensitive galvanometer. The volume of the sample is known from the diameter of the piston and its distant end from the anvil.

For charging the cell, first it is filled with argon at 7, the piston being pushed in, and then the Schlenk-vesel 8 containing the substance to be studied is attached at 9 after the stopper has been removed in an argon stream. By re-drawing the piston, the opening 10 is set free, and the substance may be filled in by turning the cell into vertical position. After returning the cell, the piston is pushed in, and then the substance is pressed. The cell has been made tight to the outer atmosphere by rubber rings 11. All measurements were performed at the room temperature (20°C).

3. results and discusion

In Fig. 2. the conductivity of the compounds Na_2(atc), $Na_{1.5}$(atc) and Li_2(atc) is plotted against the applied pressure. In all cases it increases with pressure, first as

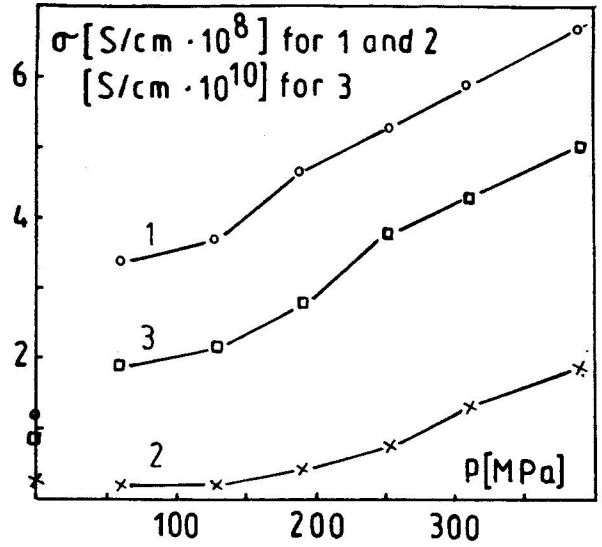

Fig. 2. Conductivity/presure plot of different alkali metal adducts of anthracene: (1) Na_2(atc), (2) $Na_{1.5}$(atc), (3) Li_2(atc) (atc=anthracene). Points on te coordinate: conductivity values after letting the pressure decrease to zero.

an s-like curve which at about 200 MPa goes over into a straight line. Unfortunatelly, pressure could not be raised more than 400 MPa for experimental reasons. So a limitting value at higher pressures has not been achieved. The values that have been found are by one order of magnitude higher that those described in literature for compounds with a similar composition [1,2]. From the slope of the curves it becomes obvious that at about 200 MPa a qualitative change of the electric properties takes place, e.g. the resistance of the grain boundary becomes decrease. Furthermore, it can be stated that the conductivity increases with a higher metal content. The sodium adduct exhibits much higher values of the conductivity than the analogous lithium compound. This all and the fact that no polarization effects could be proved suggest an electronic conduction, which is in agreement with former papers [1,2]. Within the band theoory of solids, the original acceptor level of anthracene is assumed to be broadened to a small band by which the transfer of electrons from one molecule to another becomes possible [7].

Acknnowledgement This work was supported by Deutsche Forschungsgemeinschaft.

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