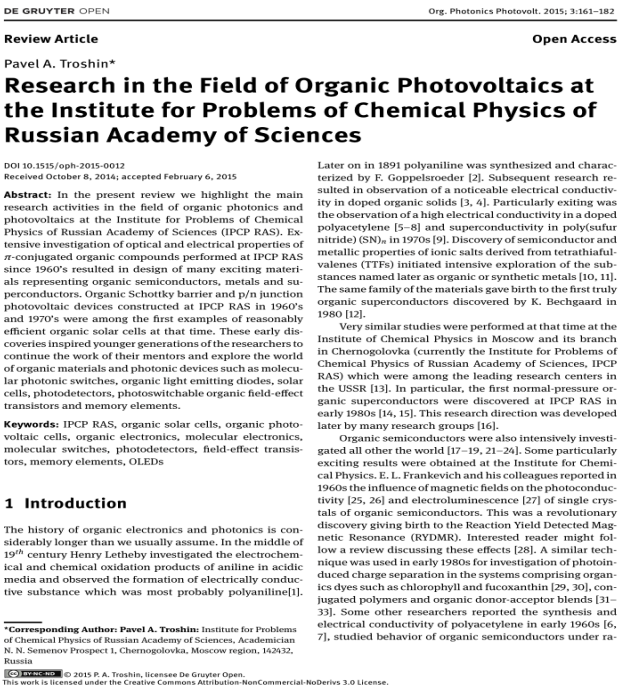
Fullerenes And Photonics II: 10-11 July 1995, San Diego, California



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Review Article Open Access

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Research in the Field of Organic Photovoltaics at the Institute for Problems of Chemical Physics of Russian Academy of Sciences

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Abstract: In the present review we highlight the main research activities in the field of organic photonics and photovoltaics at the Institute for Problems of Chemical Physics of Russian Academy of Sciences (IPCP RAS). Extensive investigation of optical and electrical properties of π-conjugated organic compounds performed at IPCP RAS since 1960's resulted in design of many exciting materials representing organic semiconductors, metals and superconductors. Organic Schottky barrier and p/n junction photovoltaic devices constructed at IPCP RAS in 1960's and 1970's were among the first examples of reasonably efficient organic solar cells at that time. These early discoveries inspired younger generations of the researchers to continue the work of their mentors and explore the world of organic materials and photonic devices such as molecular photonic switches, organic light emitting diodes, solar cells, photodetectors, photoswitchable organic field-effect transistors and memory elements.

Keywords: IPCP RAS, organic solar cells, organic photovoltaic cells, organic electronics, molecular electronics, molecular switches, photodetectors, field-effect transistors, memory elements, OLEDs

1 Introduction

The history of organic electronics and photonics is considerably longer than we usually assume. In the middle of 19^{th} century Henry Letheby investigated the electrochemical and chemical oxidation products of aniline in acidic media and observed the formation of electrically conductive substance which was most probably polyaniline[1]. Later on in 1891 polyaniline was synthesized and characterized by F. Goppelsroeder [2]. Subsequent research resulted in observation of a noticeable electrical conductivity in doped organic solids [3, 4]. Particularly exiting was the observation of a high electrical conductivity in a doped polyacetylene [5–8] and superconductivity in poly(sufur nitride) $(SN)_n$ in 1970s [9]. Discovery of semiconductor and metallic properties of ionic salts derived from tetrathiafulvalenes (TTFs) initiated intensive exploration of the substances named later as organic or synthetic metals [10, 11]. The same family of the materials gave birth to the first truly organic superconductors discovered by K. Bechgaard in 1980 [12].

Very similar studies were performed at that time at the Institute of Chemical Physics in Moscow and its branch in Chernogolovka (currently the Institute for Problems of Chemical Physics of Russian Academy of Sciences, IPCP RAS) which were among the leading research centers in the USSR [13]. In particular, the first normal-pressure organic superconductors were discovered at IPCP RAS in early 1980s [14, 15]. This research direction was developed later by many research groups [16].

Organic semiconductors were also intensively investigated all other the world [17–19, 21–24]. Some particularly exciting results were obtained at the Institute for Chemical Physics. E. L. Frankevich and his colleagues reported in 1960s the influence of magnetic fields on the photoconductivity [25, 26] and electroluminescence [27] of single crystals of organic semiconductors. This was a revolutionary discovery giving birth to the Reaction Yield Detected Magnetic Resonance (RYDMR). Interested reader might follow a review discussing these effects [28]. A similar technique was used in early 1980s for investigation of photoinduced charge separation in the systems comprising organics dyes such as chlorophyll and fucoxanthin [29, 30], conjugated polymers and organic donor-acceptor blends [31–33]. Some other researchers reported the synthesis and electrical conductivity of polyacetylene in early 1960s [6, 7], studied behavior of organic semiconductors under ra-

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