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An Eulogy to Ján Dušan Skalný 1944-2008

It is difficult to be present at this SAPP meeting and not see our great friend and colleague Professor Ján Dušan Skalný, for this was very much a conference series in his image, good science discussed in a wonderful location by a scientific family for which Dušan was the 'father'. His sudden and unexpected death on October 17, 2008 was particularly tragic for me and my colleagues at the Open University where Ján Dušan has been a visiting Leverhulme Professor since May, 2008. Although we had been fortunate to have him visit us on many occasions this extended (one year) fellowship was proving to be a wonderful experience both for its scientifically productivity and the social interactions that his presence attracted. In his last few months he made a whole new set of friends, from the academic and research staff, students to the administrative and technical staff, his death was grieved by many who had known him but a short time but who will never forget his zest for science and for life.

It is therefore fitting that we dedicate this SAPP conference to him and take the opportunity to review his long and distinguished career. Ján Dušan Skalný will always be associated with the Comenius University in Bratislava, where he started his professional career as a researcher and scientist in 1966 in the Department of Experimental Physics. His original research was focused on the development of high pressure discharges and it was a field in which he established an international reputation, indeed it was the topic of his Leverhulme Professorship and we were working on a joint paper on cluster ions produced in atmospheric discharges in the week of his death. Anyone who knew Dušan would recognise that he was not likely to take too kindly to direction and accordingly during the communist era in the former Czechoslovakia his career was restricted and he was only able to flourish after the collapse of the iron curtain in 1989. In 1991 was finally appointed associated professor and in 1998 to full professorship in Plasma Physics at Comenius' University. From 1996 (when I first met him) to 1999 he was Head of the Department of Plasma

Physics at the Comenius University and quickly sought to ensure that the Department built ties with other International groups and 'joined the New Europe'. Soon his students were visiting many of our laboratories as Dušan sought to promote the careers of many young Slovak physicists. Ján Dušan was quick to engage with international projects on the European level being the Slovak representative on many of the EU programmes we have, as a community, benefited from in last decade (EPIC, RADAM, EIPAM, and ECCL) and since 2006 he was Head of the Research Unit of the Slovak Association to the EURATOM Fusion. He was member of several international scientific committees (e.g. HAKONE, ESCAMPIG) and a referee for many journals, always providing authors with thoughtful insight and often a list of relevant references they had not quoted! Ján Dušan also willingly organised many conferences, always taking great care not only to ensure a strong scientific programme but that the conference has plenty of time for networking and building those personal links that lead to so much of our science, he was truly an excellent host.

We have therefore not only lost a close scientific colleague but a true friend. Whilst we will remember him at this SAPP meeting I am sure he would want us to continue with the traditions and style of these meetings which so reflect his character; *work hard and play hard, live life to the full, and do so in an environment of friendship and camaraderie.*

Nigel Mason

Contents

Low-Energy Electron Transport Through High Aspect Ratio Al_2O_3 Nanocapillaries

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Abstract

Transmission of low-energy electrons (2-250 eV) through high aspect ratio Al_2O_3 nanocapillaries of different diameters (40, 140 and 250 nm) has been investigated. Two different experimental systems were used allowing various measurements of angular, energy, time and current dependence of either total or only elastically transmitted electron intensity. The total intensity of transmitted current appears to be weekly dependent on the incident electron energy and the angle defined with respect to the capillary axis, which is significantly different when only elastically transmitted electrons are detected. The results contribute to better understanding of the transport of low-energy electrons through insulating nanocapillaries and suggest possible applications.

Introduction

A great interest is devoted in recent years to the controlled transport of charge particles on a nanoscale [1-3]. Particularly, the guiding of positive ions by insulating polyethylene teraphthalate (PET) nanocapillaries was first demonstrated in 2002 [3] and have been attracting a considerable attention since then. However, although a large number of results have been published on guiding of positive ions through different types of insulating nanocapillaries (PET, Al_2O_3, SiO_2), only very recently the first experiments were reported with electrons used as projectiles [4,5]. This gives new possibilities both for a fundamental understanding of the guiding phenomenon and applications.

In this contribution we present preliminary results on a comprehensive investigation of transmission of electrons in the energy range 2-250 eV through Al_2O_3 nanocapillaries of different high aspect ratios. The measurements were performed on two experimental systems where energy and angular dependences of transmitted electron current were investigated both using an energy analyzer and only a channeltron as a detector. The results suggest a complex nature of transmission of electrons through insulating nanocapillaries, which cannot be explained simply by a guiding model proposed for positive ions but include several different channels.

Fabrication of Al_2O_3 nanocapillaries

A highly ordered hexagonally close packed Al_2O_3 nanochannels array was prepared in Louvain-la-Neuve using the self-ordering phenomenon during a two-step anodization process of a high purity (99.999%) 0.5 mm tick aluminium foil. To prevent a macroscopic charge-up of the target surface, niobium layers of 20 nm thickness were deposited by dc-sputtering on both sides of the final well-ordered honeycomb membrane. A more detailed description of the fabrication process has been given elsewhere [6]. The diameter of the used Al_2O_3 capillaries is about 40, 140 and 270 nm, the intercapillary distance about 100, 320 and 450 nm, respectively, while the length is about 15 μm. The calculated geometrical transparency is about 14.2%, 8.4% and 28.5%, respectively.

Experimental setup

The measurements were performed on modified electron beam spectrometers placed at the Institute of Physics Belgrade, which were described elsewhere [7,8]. The first one (UGRA) [7] is characterized by the energy resolution of about 0.5 eV and allows measurement with higher electron energies (100-350 eV);

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variation of both tilt angle and observation angle, and energy analysis of transmitted electrons. The second one (SPEPRA) [8] posses a resolution of about 0.05 eV and allows using low electron energies (2-120 eV); variation of only the tilt angle and both energy analysis of transmitted electrons and integral detection (channeltron). Both systems are equipped with a turbomolecular pump producing base pressure of about 2-4×10^{-7} mbar.

Results

The intensity of the signal of transmitted electrons as a function of the incident energy is shown in figure 1a. For the integral acquisition the measured signal slowly decreases with decreasing the electron energy and considerable counts were measured even below 5 eV. However, the energy dependence of elastically transmitted electrons shows a steep decrease with incident energy, in contrast to the integral measurements. Also, the measured intensity of the transmitted electrons as a function of the tilt angle (figure 1b) shows flat distributions for the integral detection, while a rapid decrease is obtained for elastic signal.

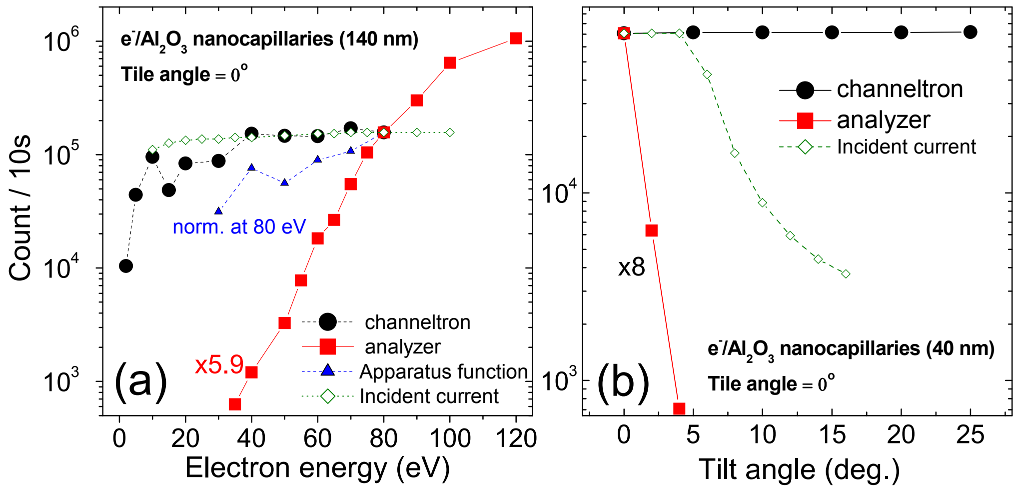

Fig. 1: Intensity of the signal of electrons transmitted through Al_2O_3 nanocapillaries measured as a function of the incident energy (a) and the tilt angle defined by the incident beam direction and the capillary axis (b).

To conclude, electron-wall interaction and secondary electron emission seem to influence strongly the electron transport through insulating nanocapillaries. The present results also suggest a possibility to manipulate electrons at significantly low energies on a nanoscale.

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