DOTCHI EXEROWA

(1935-2017)

Dotchi Exerowa has passed away on October 02, 2017 in Sofia. The Bulgarian and international colloid and interface community has lost a scientist of high professional authority and a prominent representative of the Bulgarian School of Colloid and Interface Science.

Dotchi Exerowa was born on May 20, 1935 in the town of Varna, Bulgaria. In 1958 she graduated Chemistry at Sofia University "St. Kliment Ohridski" with honors and joined the newly founded Institute of Physical Chemistry at the Bulgarian Academy of Sciences (IPC-BAS), where the Department of Interfaces and Colloids was headed by Professor Alexei Scheludko, founder of the Bulgarian School of Colloid and Interface Science. Dotchi Exerowa completed her PhD-thesis ("Free thin liquid films and foams") in 1969 and got habilitation in 1971. In 1987 she completed her Doctor of Science Thesis ("Formation and Stability of Black Foam Films"). In 1983 she succeeded Professor Scheludko as Head of the Department of Interfaces and Colloids in IPC-BAS and led the Department until 2005. Parallel with her duties at IPC-BAS she also lectured on "Physicochemical methods in biology", "Foams and emulsions" and "Physical chemistry of liquid interfaces" at the Sofia University. In 1988 she became Professor in Physical Chemistry and in 2004 was elected as Full Member of the Bulgarian Academy of Sciences.

The start of the scientific career of Dotchi Exerowa coincided with the brilliant period when the basis of surface forces studies in the vicinity of fluid interfaces was being put down worldwide. Her research activity actually began in 1958 when she elaborated her MSc thesis entitled "Electrostatic disjoining pressure in foam films" under the supervision of Alexei Scheludko. This

study was published soon thereafter in Kolloid Zeitschrift [1]. Three conceptual papers that followed may be considered as benchmarks for the further development of the Bulgarian School of Colloids and Interface Science [2,3,4]. Her subsequent scientific achievements were related to the study of surface forces in thin liquid films, as well as to the adjoining aspects in physics and chemistry of interfacial phenomena. They might be grouped into three major trends: (i) new scientific instrumentation, (ii) pioneering new research results, (iii) innovative applications of the new scientific results.

New scientific instrumentation: In the course of several decades microscopic foam films have been one of the most actively investigated research topics of colloids and interfaces. Their specific kinetic and thermodynamic properties promote them as a simple and comprehensible model for the investigation of surface forces and the stability of disperse systems. They have also an important independent role as a vital constituent of biological systems thus bridging the fundamental physicochemical knowledge with biology, biomedicine, biotechnologies and life sciences. The progress in this research field is based on the effectiveness of various experimental methods developed for the formation and the investigation of thin liquid films. One of the most successful techniques for the study of these films is the microinterferometric setup for the formation and investigation of thin films, put forward in the sixties of the 20^{th} century by Dotchi Exerowa and Alexei Scheludko. The key element of this setup is the so-called Scheludko–Exerowa cell. Using this cell, the first experimental verification of the classical theory of Derjaguin, Landau, Verwey and Overbeek (DLVO-theory) was accomplished [1,5]. Later on, this methodology was modified and further developed by Exerowa and her research group and applied for the investigation of a variety of fluid systems. Particularly important is the novel modification – Thin Liquid Film Pressure Balance Technique (TLF-PBT), which allows the direct measurement of interaction forces in the microscopic liquid films, gaining the disjoining pressure/film thickness isotherms ($\Pi(h)$) for a wide range of thickness values and pressures, including the transition region of common black/Newton black films (CBF/NBF).

The Scheludko-Exerowa microinterferometric technique turned out to be a very reliable research instrumentation and is now used worldwide in most cases where surface forces at fluid interfaces are investigated. Variations of these setups are working in a number of laboratories: University of California in Berkley (USA), Technical University of Virginia (USA), Max-Planck Institute of Colloid and Interface Research in Potsdam (Germany), Moscow State University

(Russia), Institute of Surface Chemistry, Stockholm (Sweden), Ecole Normale, Paris (France), Institute of Food Research, Norwich (UK), etc. In the recent decade Dotchi Exerowa had initiated the design of the latest version of the microinterferometric technique with the additional option for electrochemical investigations of the thin liquid films. It was constructed by Exerowa's collaborators [6,7] in partnership with Canadian colleagues (University of Alberta and CanmetENERGY, Edmonton). The technique is applied for the investigation of emulsion films, stabilized with natural surfactants. These thin liquid films are of crucial importance for understanding the properties of disperse systems, which are obtained in oil, pharmaceutical, cosmetic and food industries.

Pioneering new research results: Historically, the microscopic foam film was the first simple model of two interacting fluid interfaces. Using the microscopic foam film model Exerowa and collaborators had investigated fundamental aspects of the formation and stability of foam films. It was verified for the first time that there are two types of equilibrium films: Common black films (CBF) and Newton (bilayer) black films (NBF). One of the basic research trends to which Exerowa had a significant contribution was the detailed investigation of the NBFs. A new theoretical approach to explain their formation and properties was proposed with NBFs regarded as a 2D-ordered system. The rupture of the bilayers was related to a fluctuation mechanism of nanoscale hole formation. The hole formation was treated as a nucleation process of a new phase in the 2D-system (NBF). The leading role of the amphiphile concentration and the short-range intermolecular forces for the formation and stabilization of these films was precisely verified. One of the basic achievements of Exerowa and her group was the promotion of the NBF as an efficient model for the study of interaction forces in biological membrane configurations.

Innovative applications of the new scientific results: Although the primary accomplishments of Dotchi Exerowa concerned the fundamental studies of fluid interfacial properties and interactions, in many cases she had managed to transfer the obtained results into innovative advances and applications. One indicative example was the development of a new method for the estimation of the lung maturity of neonates. As it is well-known, the deficiency of the lung alveolar surfactant causes lung immaturity and leads to the so-called Respiratory Distress Syndrome (RDS) in newborns. Through the investigation of bilayer films formed from phospholipids and the components of alveolar surfactant Exerowa and collaborators demonstrated that NBFs may be applied successfully for the exploration of alveolar surfactant insufficiency. The

microscopic foam film was proposed as a novel *in vitro* model for the study of the alveolar interface and the estimation for the stability of the alveoli. Based on this model a new method for early diagnostics of lung maturity of neonates was proposed and a new methodology for the design and optimization of therapeutic pulmonary preparations was developed. The method was often named Exerowa Black Film method [8] and is implemented in a number of medical institutions in Bulgaria, Europe and USA. In recognition to these accomplishments Dotchi Exerowa was elected as a member of International Association for Lung Surfactant System and of EURAIL Commission ("EURope Against Immature Lung"). The very good correspondence of the clinical results and the parameters of the *in vitro* model evoked a new hypothesis for the structure of the alveolar surfactant layer. This is the so-called "bilayer-monolayer model" which allows deeper understanding of the major physiological process – breathing [9].

Another significant application trend was the study of the properties and the stability of foams. Starting from the experience on foam films, Dotchi Exerowa and her group had succeeded in relating their peculiarities to the stability of foam systems. The basic success here was the elucidation of the role of the foam film type (common thin, common black or bilayer) for the lifetime and the syneresis (drainage) of foams [10]. The obtained results were very useful for the optimization of real foam-producing formulations, to be used e.g. in firefighting, food and cosmetic industries.

Many of the Exerowa's research results were included in the monograph "Foam and Foam Films", first published in 1990 (Khimiya, Moscow). The second edition, extended and revised, was published by Elsevier in 1998. She had also authored a number of chapters in the encyclopedic books edited by: Hans Lyklema ("Fundamentals of Interface and Colloid Science", Elsevier, 2005); Johan Sjöblom ("Emulsions and Emulsion Stability", CRC Taylor&Francis, 2005); Tharwat Tadros ("Emulsion Science and Technology", Wiley-VCH, 2009); Victor Starov ("Nanoscience: Colloidal and Interfacial Aspects", CRC Press, Taylor&Francis, 2010); Hiroyuki Ohshima and Kimiko Makino ("Colloid and Interface Science in Pharmaceutical Research and Development", Elsevier, 2014). In 2007 was published the book "Colloid Stability – The Role of Surface Forces", Ed. Th. Tadros, Wiley-VCH, in two volumes dedicated to the anniversaries of Dotchi Exerowa and Dimo Platikanov. In 2009 another book, "Highlights in Colloid Science" (Wiley-VCH), was published with her being a co-editor. Dotchi Exerowa is also co-editor of the book „Foam Films

and Foams: Fundamentals and Application“, presently in press with CRC Press, to appear in early 2018.

During her long and successful scientific career Dotchi Exerowa had initiated and developed numerous research contacts and scientific collaborations with leading scientists and research laboratories in the field of physical chemistry of interfaces and colloids (France, Great Britain, Germany, Spain, Poland, Russia, Canada, Italy, Japan, etc.). She was elected in the Scientific Committees of many international conferences and symposia. She was member of the Editorial Boards of leading colloid chemistry journals (Current Opinion in Colloid and Interface Science, Advances in Colloid and Interface Science, Colloids and Surfaces A, Colloid and Polymer Science, Colloid Journal (in Russian)). In 1997, she was a co-chair (together with Dimo Platikanov) of the 9th International Conference on Surface and Colloid Chemistry, organized under the aegis of International Association of Colloid and Interface Scientists (IACIS). Professor Exerowa had also been elected twice as a Member of the IACIS Council and was closely engaged in the development and the organizational advance of the international colloid and interface scientific community. A tribute to the high quality of her research achievements and fruitful international collaborations was the international symposium (Dotchi Exerowa Symposium – Smart and Green Interfaces: Fundamentals and Diagnostics) held in Sofia, October 29-31, 2015 and dedicated to her 80th anniversary. More than 110 researchers from 23 countries had participated in this event and a special issue with selected papers was published recently in Colloids and Surfaces A: Physicochemical and Engineering Aspect, vol. 519, 2017.

The death of Dotchi Exerowa is a great loss to the colloid and interface community. By her colleagues, collaborators and former students she will be remembered for her deep passion for science, the wide horizon of the research interests and the keen intuition to address challenging problems, thus advancing truly basic and pioneering studies. The legacy of the important results of her scientific, teaching and applied activities constituted a vital contribution to the productive development of the Bulgarian School of Colloid and Interface Science and were key pillars supporting the progress and international reputation of this School.

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