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Permeability of an Ideal Symmetric Liquid Crystal Based on Carbon Nanotori

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Abstract: Molecules of carbon ideal nanotori can form columnar phases with symmetric parallel optical axes due to the large depth of potential wells in direction of tori axes. The formed columns are often called "liquid lines". They are the principal fragments constituting the liquid crystal. Along the axes of these structural formations, not only light quanta can propagate, but also atomic or molecular particles of some gas components. This fact is used in this report for membrane separation of gas mixtures under standard temperature conditions. The nanotor itself is a surface crystal. Many papers talk about the applications of nanotori and their physical properties. However, the collective effects of these objects, the states and properties of symmetric liquid crystals obtained on their basis, have been little studied. In this report, two approaches are used to study the permeability of liquid crystal films. The first is the atom-atom interaction approach. According to this approach, the nanotor is represented by a set of carbon atoms located in their middle positions. These atoms interact with free atoms (molecules) of the gas phase. The second approach is based on finding the integral action directly from the nanotorus or effective surface approximating such an action. For points located on axes of liquid lines, it is convenient to take the surface of ring as approximating surface, which has the same size as the central section of torus. A columnar carbon structure, built in one of the ways, is shot with beams of atoms or simple molecules of gas phase in the direction of the axes of liquid lines. The results of numerical experiments are used to determine the permeability of a liquid crystal film and the selectivity of separating a gas mixture using a layer of such films.

Keywords: nanotori; liquid crystal; permeability; selectivity; gas mixture

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