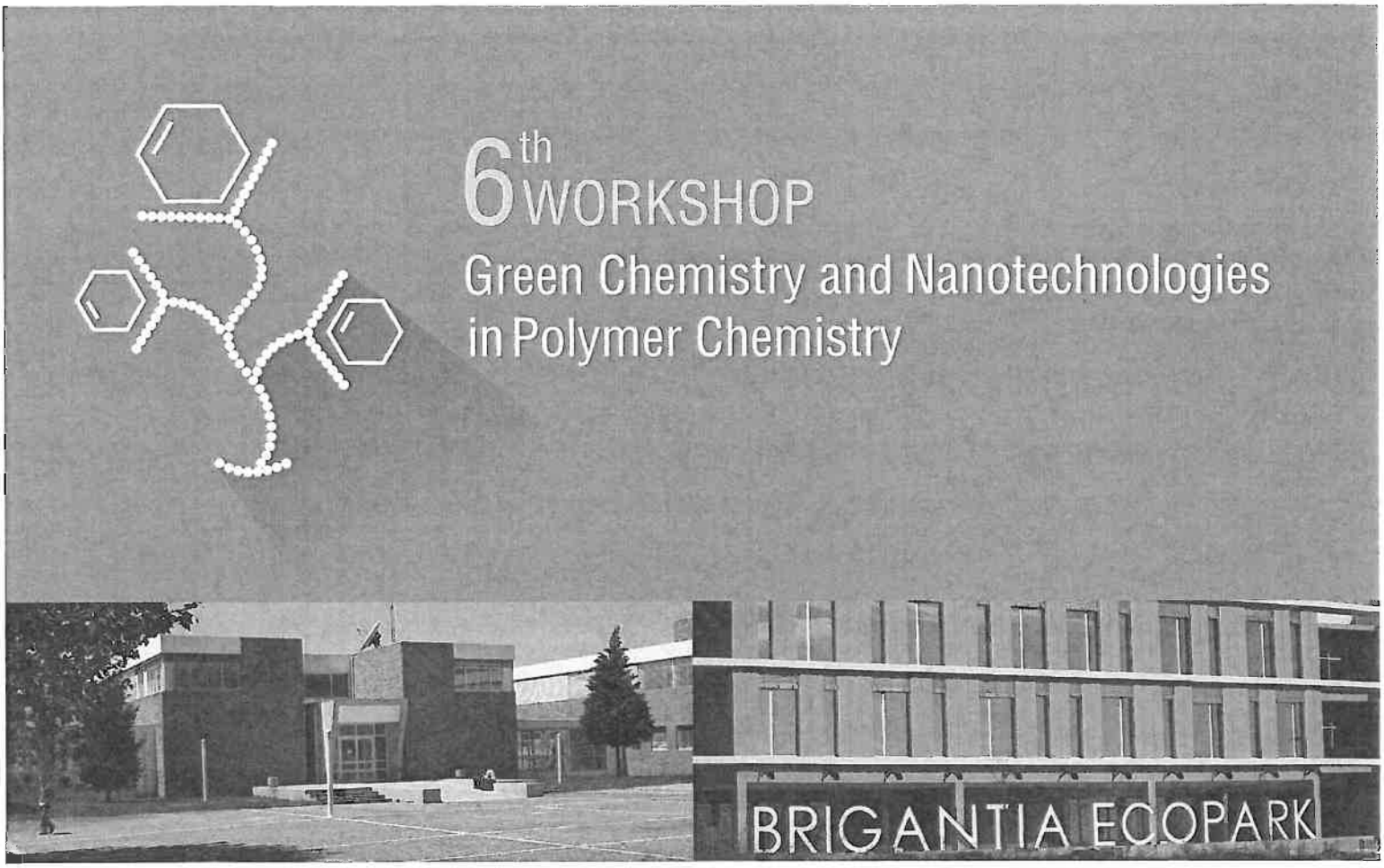

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WORKSHOP PROCEEDINGS

Eds. - M. F. Barreiro, O. Ferreira, A.I. Pereira

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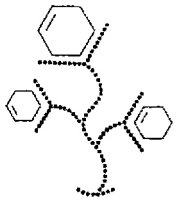

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P16. VISUALIZATION OF A PMMA BLOOD ANALOGUE FLUID FLOWING THROUGH A HYPERBOLIC MICROCHANNEL

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Introduction

Axial migration of individual red blood cells (RBCs) is a well known effect that happens in microchannels with dimensions below 300 μm. This effect is known as the Fåhræus-Lindqvist effect gives place to a cell free layer (CFL) of plasma located around the walls of the microchannel [1]. Several flow studies regarding the CFL measurement exist in *in vitro* [1-3] environments. However, the manipulation of *in vitro* blood is often difficult due to the ethical, economical and safety issues involved. As a result, the development of blood analogue solutions is needed to improve our understanding regarding the blood flow behaviour in microchannels and microvessels.

Although several studies using one-phase Newtonian and non-Newtonian blood analogues can be found in the literature [4, 5], there are few works related with the use of particulate solutions in which the particles mimic the RBCs behaviour. The present work proposes a particulate-viscoelastic solution made of xanthan gum and dextran with rigid polymethylmethacrylate (PMMA) spherical particles able to mimic the effect of CFL formation that frequently happens in *in vitro* blood flow systems. Flow visualizations through hyperbolic contraction microchannels were used to observe the CFL originated by the proposed blood analogue fluid. Additionally, this CFL was compared with the plasma layer formed by an *in vitro* blood sample.

Materials and methods

The composition of the working fluids used in this study is as follows: dextran 40 (Dx40, ρ_{Dx40}=1.05 g/cm^3) containing 5% by volume of ovine RBCs, and a two-phase viscoelastic solution made of xanthan gum (115 ppm) and dextran 40 carrying 5% w/w (4.4% v/v) of PMMA spherical particles of 6 μm diameter (ρ_{PMMA}=1.20 g/cm^3) with 0.05% w/w of sodium dodecyl sulfate (SDS) in order to avoid microparticles aggregation.

Polydimethylsiloxane (PDMS) hyperbolic microchannels were fabricated by using a soft-lithography technique. The dimensions of the microchannels are given by 400μm (w) × 400 μm (l) ×15 μm (h) where w, l and h refer to the width of the inlet microchannel, the length of the hyperbolic contraction region and the depth of the microchannel, respectively.

The high-speed video microscopy system used in the present study consists of an inverted microscope (IX71, Olympus) and a 10x objective lens, combined with a high-speed camera (i-SPEED LT, Olympus). The PDMS microchannel was placed on the stage of the microscope where the flow rate (Q) of the working fluids was kept constant by means of a syringe pump (Harvard Apparatus PHD ULTRA). The images of the flowing RBCs/PMMA particles were captured at the mid-plane of the microchannel using a high speed camera.

Results and discussion

Figure 1 show images recorded by a high-speed camera for both particulate blood analogue fluid and *in vitro* blood samples tested. The qualitative visualization results show clearly a formation of a CFL downstream the hyperbolic contraction. The results also show that at the contraction upstream the CFL was negligible.

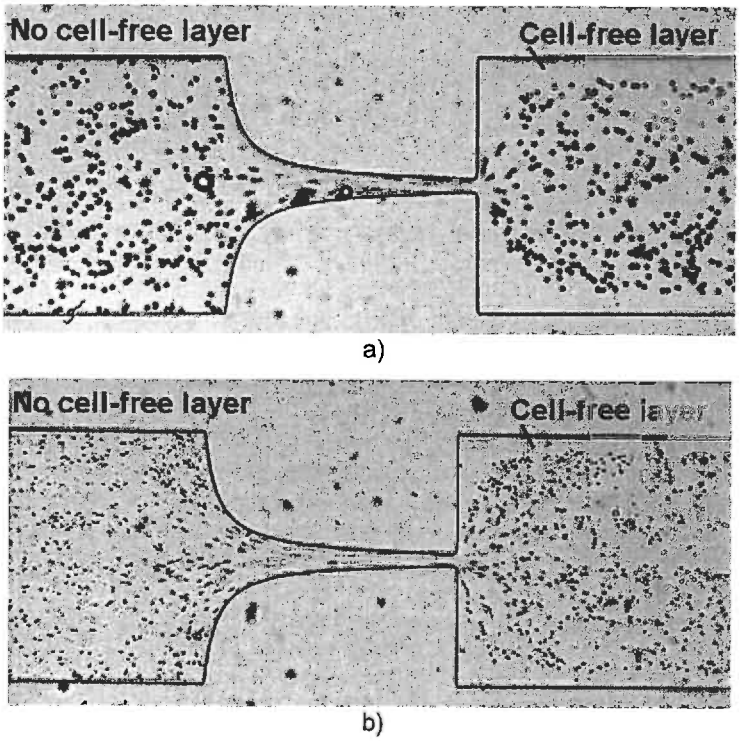

Fig. 1. Images of (a) PMMA particles and (b) RBCs flowing through a hyperbolic microchannel.

Although the results show a good agreement regarding the CFL obtained for the blood analogue solutions and for the real blood, it also possible to observe that the CFL formed by the PMMA particles downstream the contraction is slightly bigger than the one formed by the RBCs. Note that, for the fluid containing RBCs, the suspension fluid is Newtonian (no elasticity and constant viscosity), while in the case of the PMMA particles, the suspending fluid is shear thinning and slightly elastic. Hence, we believe that the observed deviation is mainly due to the rheological differences that exist between the two suspending fluids.

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