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Dr. Robert H. Lacombe
Chairman
Materials Science and Technology
CONFERENCES, LLC
3 Hammer Drive
Hopewell Junction, NY 12533-6124
Tel. 845-897-1654, 845-592-1963
FAX 212-656-1016
E-mail: rhlacombe@compuserve.com

CELLULAR ADHESION AND THE COVID-19 VIRUS

EDITORIAL COMMENTS

The first item of business in this issue of the Newsletter is to announce the postponement of all MST events originally scheduled for the Spring and Summer of this year. In particular the short course on The Chemistry, Physics and Mechanics of Surface Science and Adhesion and the 12th in the Contact Angle symposium series will be postponed till no earlier than the Fall of this year. The current uncertainty as to just how the pandemic is going to play out makes it difficult to set specific dates at the moment since it is not clear whether or not there might be a resurgence of the virus in the Fall or not. In this regard we are asking all potential participants in these events to give us their perspective on their prospect for resuming travel sometime this coming Fall. We can most easily be reached by E-mail (rhlacombe@compuserve.com) and we would be most eager to learn your outlook on this problem.

As the virus pandemic is very much at the top of the news these days we feel it is highly apropos to devote this issue to the recent passing of Prof. Carel Jan van Oss, a microbiologist, who was very active in the area of contact angle behavior as applied to surface phenomena in biological systems. Prof. Van Oss was a good friend and frequent contributor to the MST Contact Angle symposium series. His work on cell adhesion will be commented upon below as it is quite relevant to the mechanism of viral attack on living cells.

IN MEMORIAM: Carel Jan van Oss, September 7, 1923 - February 22, 2018

Figure 1: Carel Jan van Oss.

Whereas Prof. van Oss is known to most members of the Contact Angle community in regard to the van Oss-Chaudhury-Good Equation[1] what is much less known is that he had a rather swashbuckling career early in life as a participant in the Dutch resistant movement against the Nazi occupation of Holland during World War II by making false identity papers for refugees from Hitler's invasion.

In an interview to a reporter he explained how this came about:

> *"I was about 18, just out of school. It was a matter of some of our classmates being in some difficulties. We were fairly adept in meticulous drawing from our school days, so we offered to do it and see what came of it, Quickly acquaintances in the Resistance heard about this and thought this is precisely what they needed, so they put me to work."*

Forging passports and other identity papers was a rather hazardous undertaking in those days as the Gestapo were continually becoming more adept at detecting forgeries. But, Carel and his associates managed to stay one step ahead by developing methods for transferring photographs and recreating official stamps by using acetone to

[1] "Monopolar Surfaces", van Oss, C. J.; Chaudhury, M. K.; Good, R. J.; Adv. Colloid Interface Sci.; 28, 35 (1987)

dissolve markings. All of this activity eventually led to his capture and imprisonment.

In all he estimated that his group created some 900 identity cards for Dutch Jews, which helped them to escape to Switzerland. They also forged documents for Allied pilots who had been shot down during bombing raids.

His career as a forger came to an end at the conclusion of the war and he then went on to a quite distinguished career as a microbiologist.

In summary:

He edited three scientific journals, two of which he founded.

He authored or was co-author or editor of 11 scientific books in three languages.

He published more than 360 scientific papers and chapters.

In 1980, he was appointed an adjunct professor in the Department of Chemical Engineering at the University of Buffalo.

In 1995 he became an adjunct professor in the University of Buffalo's Geology Department.

He was a member of the Ernest Witebsky Center for Immunology at the University of Buffalo and held visiting positions at the Central Laboratory of the Netherlands Red Cross Blood Transfusion Service at Amsterdam and at the University of Bristol in England.

In 1983, he was awarded the Netherlands Commemorative Resistance Cross for his actions during World War II. Queen Beatrix also awarded him a knighthood in the Order of Orange-Nassau.

He was further honored with the Righteous Among the Nations Humanitarian Award in 1994 from the Buffalo Chapter of the American Jewish Committee.

The last time Prof. Van Oss presented at an MST symposium was at the 6th in the Contact Angle series held at the University of Maine where he presented a paper on "Energetics and Kinetics of Specific Ligand-Receptor (Including Antigen-Antibody) Interactions". This topic is highly apropos these days when the world is very much interested in the details of Antigen-Antibody Interactions in regard to the current virus pandemic.

Carel Jan van Oss: forger, microbiologist and humanitarian, we benefitted greatly from his participation in previous symposia and his contributions to Contact Angle behavior are still very much with us today.

CELL ADHESION AND THE MECHANISM OF VIRAL ATTACK ON HUMAN CELLS

Interestingly enough the topic of cell adhesion was covered in the last of the many books published by Prof. Van Oss entitled "Interfacial Forces in Aqueous Media" (CRC Press Taylor Francis Group (2006)). At the very beginning of the chapter on cell adhesion he points out that cell adhesion is an extremely complex topic due in particular to the following circumstances:

1. Cells exhibit many capabilities and mechanisms which strongly affect adhesion behavior including:

    a. Diverse surface heterogenity
    b. Motility
    c. Endocytosis
    d. Exocytosis
    e. Pinocytosis
    f. Spiculation
    g. Formation of pseudopodia
    h. Excretion of biopolymers and various solutes

2. Surface adsorption of proteins and other biopolymers modify the cell/substrate interphase thus influencing adhesion behavior in unexpected ways

3. Different mechanism of adhesion and adsorption apply to low and high energy surfaces

4. Very different mechanisms of adhesion occur at the microscopic and macroscopic levels

Given the above listed impediments it is no wonder that cell adhesion is still very much a topic on the frontier of current research. However in his volume Prof. van Oss sheds some light on the mechanism on virus attachment to a cell surface.

It is well known that all virus particles have coarse bumpy surfaces similar to what is shown in the right hand shape B drawn in figure (2). It turns out that there exists an electrostatic repulsive force between the particles and various body cells due to a secondary maximum in the interaction potential as shown in figure (3). The potential curve shown in the figure is the sum of dispersion forces, acid-base interactions and electrostatic repulsion forces. It is the electrostatic repulsion is what gives rise to the local maximum at a distance Δ from the cell surface thus preventing the smooth particle labeled A in the figure

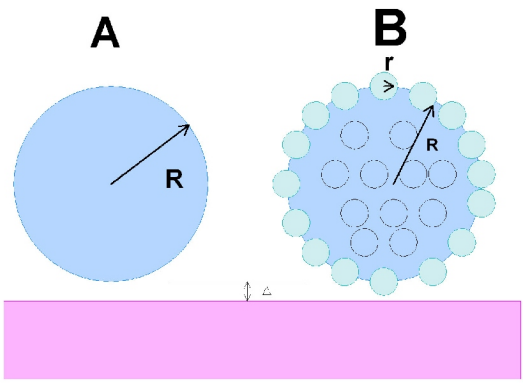

Figure 2 Two particles of identical radius R approaching a relatively flat surface. Particle A is prevented from approaching the surface closer than a distance Δ due to electrostatic repulsion. The small radius protuberances on particle B allow it to penetrate to the surface due to the weaker electrostatic repulsion on it's small radius projections.

from making contact. The small protuberances on particle B carry much less charge due to their much smaller surface area thus greatly weakening the magnitude of the potential maximum. Thus the small protuberances on particle B allow it to get by the local maximum and thus allow it to attach firmly to the cell surface via the strong potential minimum.

After making contact with the cell surface any number of complicating factors as listed above in items 1-4 can come into play. In the case of viral particle attack, the process of endocytosis is the most likely event which leads to the adsorption if the particle into the cell's interior where it then proceeds to multiply itself using the cell's reproductive machinery.

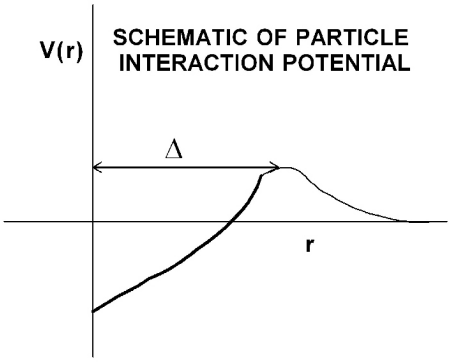

Figure 3 Qualitative nature of the interaction potential between particles and a typical cell surface. The potential curve is the net result of dispersion acid-base and electrostatic interactions. In particular the electrostatic interactions contribute most to the local maximum at r = Δ.