Thromboelastography cups and pins for improved blood coagulation testing: Surface modification by plasma coating

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One of the current challenges to render the performance of bio-technologies such as thromboelastography (TEG) more reliable is the development of new materials; in the case of TEG, control of the coagulation properties of anticoagulated blood plasma and unmodified whole blood are currently not satisfactory. Plastic cups used to hold the blood sample being analyzed are made of "Cyrolite", a type of methacrylate, in which the clotting processes starting between 15 to 60 min are uncontrollable. The contact coagulation pathway can be triggered by selective adsorption of Factor XII to negatively charged surfaces, such as silicates, which alters the protein conformation to expose a serine protease active site. We began with the hypothesis that surface-modification of TEG cups and pins will change the coagulation behavior of recalcified, citrated human blood plasma and of unmodified human whole blood: The presence of (positively-charged) amine groups should inhibit clotting, while (negatively-charged) carboxylate ($-COO^-$) groups should accelerate it [1,2]. Therefore, surfaces of TEG cups and pins were modified so as to change their properties, for example their surface chemistry and free-energy, and thereby to promote reproducible, rapid clotting time. This is being examined by using four different types of glow-discharge plasma deposits: (i) "low-pressure N-containing plasma-polyethylene" (L-PPE:N), rich in primary amine groups [3]; (ii) its O-containing counterpart (L-PPE:O) with COO^- groups; (iii) plasma-polymerized hexamethyldisiloxane (PP-HMDSO), to create a hydrophobic surface [4]; and (iv) silica (SiO_2, glass-like coating) from a HMDSO/O_2-Ar mixture. TEG cups and pins with these different surfaces were tested for the coatings' influence on TEG performance. Custom-made metal electrode-moulds assured complete contact with the cups' slightly tapered outer walls, while silicon wafers placed inside the cups and XPS analyses were used to monitor uniformity and composition of deposits. Preliminary data show that anionic coatings tended to accelerate coagulation of recalcified human plasma, while cationic ones slightly delayed coagulation time. These observations are consistent with differential interaction of the modified TEG cups with clotting factors of the contact pathway such as Factor XII.

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References

[1] Bakas L.S., Saint-Pierre Chazalet M., Bernik D.L., Disalvo E.A., Colloids and Surfaces B: Biointerfaces (1998), **12**, 77–87.
[2] Olson S.T., Richard B., Izaguirre G., Schedin-Weiss S., Gettins P.G.W., Biochimie (2010), **92**, 1587-1596.
[3] Ruiz J.-C., St-Georges-Robillard A., Thérésy C., Lerouge S, Wertheimer M.R., Plasma Processes and Polymers (2010), **7**, 737–753.
[4] Wertheimer M.R., Klemberg-Sapieha J.E., Cerny,S. Liang J., Plasmas and Polymers. (1998), **3**, 151-163.