Modulating Bioactivity with Gold Nanoparticles

S. Albertini[a,b], F. Laimer[a], L. Tiefenthaler[a], S. Flatscher[b], F. Zappa[a,c], M. de Araujo[c], H. Schöbel[b], L. Huber[c], and P. Scheier[a]

[a] University of Innsbruck, Institute for Ionphysics and Applied Physics, Austria
[b] Management Center Innsbruck, Department Biotechnology & Food Engineering, Austria
[c] Instituto de Ciências Exatas, Departamento de Física, Universidade Federal de Juiz de Fora, Brazil
[d]Medical University Innsbruck, Division of Cell Biology, Austria
simon.albertini@uibk.ac.at

Between single particles and bulk matter lies the realm of clusters. Small clusters, consisting of several tens of atoms or molecules, often show strong quantum effects that are dependent on the number of particles constituting the cluster. This can lead to what is called superatomic properties where a cluster mimics the behavior of an atom or even surpasses it. The Al_{13} cluster for example shows a higher electronegativity than fluorine and Na_2 to Na_{20} clusters show a similar behavior – e.g. in their electronegativity and ionization potential – as the elements ordered by increasing proton count.

In a similar manner, gold cluster made up of exactly 8 atoms mimic the electronic structure of a noble gas. Au_7 clusters thus show a relatively high electronegativity and Au_9 clusters a relatively low ionization potential. As the elements of the alkali metals with one valence electron, Au_9 clusters try to reach a noble gas-like state by loss of one electron, leaving the cluster itself positively charged.

Our working group has managed to find a way of efficiently producing monodisperse clusters in super cold helium nanodroplets and depositing them on a variety of surfaces. Due to their electronic properties, this enanbles us to make directed manipulations to surface charges. Since it has been shown that surface charge greatly alters cell adhesion behavior, coatings with precisely size selected gold clusters are a way to tune bioactivity.

In this work, the optimal parameters for depositing, sterilization and coating density as well as the effect of the treated surfaces on a model cell line are investigated. We gratefully acknowledge the financial support by funding from EFRE (K-Regio project FAENOMENAL, grant number EFRE 2016-4).