# DESIGN OF "GREEN" CHEMICALS AND BIOMATERIALS WITH TAILORED PROPERTIES BASED ON HUMIC SUBSTANCES

**Perminova I.V.,[a] Karpiouk L.A.,[a] Ponomarenko S.A.[b], Kovalenko A.N.,[a] Shcherbina N.S.[a], Bolkova A.N.,[a] Kulikova N.A.[c], Tsvetkova E.A.[d], Muzafarov A.M.[b], Petrosyan V.S.[a]**

*[a]Department of Chemistry, Lomonosov Moscow State University, Moscow 119992, Russia*
*[b]Enikolopov Institute of Synthetic Polymer Materials, RAS, Moscow 117393, Russia*
*[c]Department of Soil Science, Lomonosov Moscow State University, Moscow 119992, Russia*
*[d]Zelinsky Institute of Organic Chemistry, RAS, Moscow 119991, Russia*

Facing the growing needs in world consumption of mineral oil along with deterioration of its reserves, of particular importance gains development of new principles and technologies of fuel and chemicals production based on a use of alternative and renewable resources (*1*). Alternative biogenic resources are presented by fossil and technogenic materials. The former consist of oxygenated organic rocks such as leonardite, peat, sapropel, etc.; the latter include organic industrial and agricultural wastes (spent pulp liquors, activated sludge, composts, etc.). Main organic components of these resources are humic or humic-like compounds, whose inherent properties are: non-toxicity, biocompatibility, resistance to biodegradation. Despite immense reserves of inexpensive humic materials and unique biological properties; they do not find a broad practical application. Fundamental reason of that is large polydispersity and structural heterogeneity of humic substances, which translates into properties that are difficult to control. To overcome this problem, chemical modification and surface chemistry are proposed as promising tools for acquiring humic materials with desired properties.

The goals of this study were threefold: first, humic materials were modified to enhance function or property inherent within natural humics (e.g., complexation ability, redox activity); second, humic materials were modified to acquire a novel, tailored property not inherent within natural humics (mineral-adhesive ability); and, finally, humic derivatives were immobilized onto mineral support to change their physical form. Polycondensation approach was used to enhance redox and complexing properties of humics. This approach allows for incorporation of the desired phenolic- or quinonic fragment with the known redox or complexing properties into the humic backbone. The obtained humic derivatives possessed much higher reducing capacity and were capable of reducing Np(V) to Np(IV), which is not possible with native HS. To introduce new function in native humic materials, alkoxy-silylation was used. Incorporation of alkoxysilyl-groups yielded humic derivatives capable of covalent binding with hydroxyl-carrying surfaces (e.g. silica gel) (*2*). The obtained derivatives were water soluble and could be immobilized onto mineral supports under mild ambient conditions from aqueous solutions. The test for sequestration of radionuclides and bacterial endotoxin (lipopolysacharide) has shown that the produced coatings completely sequestered Pu(V) and possessed substantial affinity for bacterial endotoxin. Of importance is that all humic derivatives synthesized did not acquire toxicity as a result of modification that allows for considering them and derived materials as "green" chemicals and biomaterials.

Directed modification was shown to be a promising tool for producing humic materials with tailored properties. This opens broad opportunities for commercial applications of HS.

The research was supported by ISTC (KR-964), DOE (RUC2-2006), RFBR (06-04-49017), and Interdisciplinary Science Project of the Lomonosov Moscow State University-2007.

***References***

1. Ragauskas, A. J., et al. The Path Forward for Biofuels and Biomaterials. *Science* 2006, **311**, 484.
2. Perminova, I. V. et al.: PCT Application RU2006/000102, filed on March 7, 2006.