

# Synthesis of Adhesive Silanol Derivatives and Their Sorption onto Mineral Support

Alexander B. Volikov<sup>1</sup>, Ivan V. Dubinenkov<sup>1</sup>, Eugene M. Garanin<sup>1</sup>, Vladimir A. Kholodov<sup>2</sup>, Alexander Ya. Zhrebker<sup>1</sup>, Mantsa M. Andzhushev<sup>1</sup>, Sergey A. Ponomarenko<sup>3</sup>, Irina V. Perminova<sup>1</sup>

<sup>1</sup>Department of Chemistry, Lomonosov Moscow State University, Moscow, Russia, ab.volikov@gmail.com

<sup>2</sup>Dokuchaev Soil Science Institute, RAAS, Moscow, Russia

<sup>3</sup>Enikolopov Institute of Synthetic Polymeric Materials, RAS, Moscow, Russia

The goals of this study were twofold: first, humic materials were modified to acquire a novel, tailored property not inherent within natural humics (mineral-adhesive ability); and, second, humic derivatives were immobilized onto mineral support to obtain humic biocompatible nanocoating. To introduce new function in native humic materials, alkoxy-silylation was used.

The commercial potassium humate (Sakhalin Humate, Biomir 2000 Ltd., Russia) (CHS) was used for all modifications. 3-amino-propyltriethoxy-silane (APTES) was used for treatment of CHS. The choice of APTES was provided by the presence of reactive amino groups in its structure which can yield amide bonds upon reaction with carboxyl and carbonyl groups. In addition, APTES is commercially available organosilane suitable for preparative production of the corresponding derivatives.

Silanol derivatives of CHS were obtained by its condensation with APTES. The reaction was run at five different APTES-to-humics ratios, nominally: 0.2, 0.3, 0.4, 0.5 and 1 g of APTES per g of CHS. These ratios corresponded to different extents of modification associated with carboxyl groups available within the humic backbone. Depending on modification degree, the corresponding samples were designated CHS-APTES-20, CHS-APTES-30, CHS-APTES-40, CHS-APTES-50, and CHS-APTES-100. Sorption of the modified HA was carried out on 100 mg of silica gel. The total volume of experimental solution was 10 mL, concentration of humic samples was set in the range from 0.1 to 4 g/L. All sorption experiments were conducted in phosphate buffer (0,03 M, pH 6.0). Equilibrium time was 24 hours.

Figure 1 shows sorption isotherms for the silanol derivatives samples with maximum and minimum modification degree on silica gel. It can be seen that the larger sorption was observed for the sample with maximum modification degree (CHS-APTES-100), which displayed the higher affinity for silica gel surface.

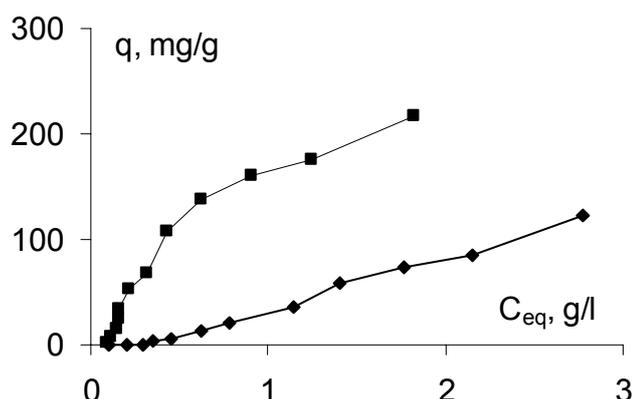


Figure 1. Sorption isotherms of the silanol derivatives of leonardite HA onto silica gel.

■ - CHS-APTES-100; ◆ - CHS-APTES-20

It was shown that all silanolized humic derivatives had high affinity for sorption on silica gel which are characterized with highly developed surface area. Maximum sorption achieved was 220 mg per gram of silica gel for CHS-APTES-100. The conclusion was made that the silanolized HS could be used for producing biocompatible coatings on mineral surfaces which can suit a whole suite of biomedical applications.

This research was supported by State Contract #16.740.11.0183 of the Ministry of Education and Science of RF.