Creation of graphene and graphane layers in hybrid organic-inorganic polymers based on complex compounds of vanadium, iron and copper

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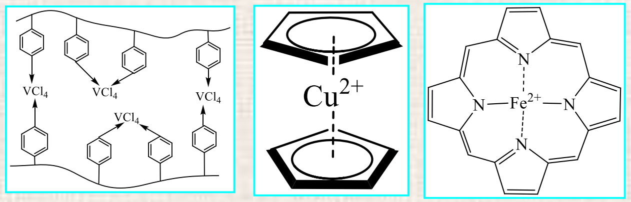
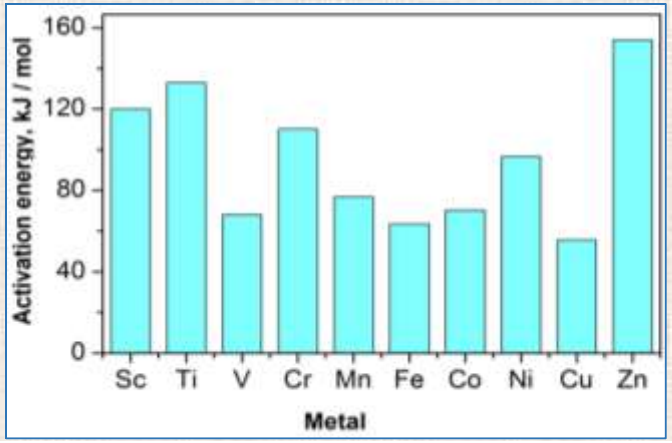
Hybrid organic-inorganic polymer systems are promising components in a wide range of modern technologies. They can be used as binders to obtain structural and functional materials with high physical and mechanical, antifriction, optical properties, as well as heat-resistant adhesives, coatings for various purposes, ion-exchange materials, membranes. Their special properties are associated with the presence in their structure of nanoscale heterogeneities of organic and inorganic nature. An organic-inorganic hybrid polymer is a polymer whose main chain is formed by inorganic and organic fragments, and the bond between the fragments can be covalent, coordination and ionic, depending on the structure of the inorganic fragment.

Based on the comparison of XRD, IR- and Raman spectroscopy data, the regularities of changes in the number of graphene and graphane structures in the material with changes in the pressure and temperature of polymerization were established (Fig. 1) and the optimal parameters for obtaining the maximum number and maximum degree of ordering of such structures were determined.

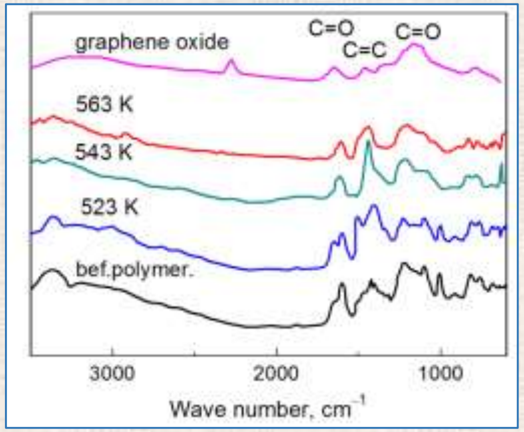
The effect of the content and size of metal nanoclusters in the oligomer on the amount of graphene and graphane structures formed in the hybrid polymer after polymerization was also studied. It was found that the use of metal clusters with a narrow size range of 1–10 nm makes it possible to increase the content of graphene-graphane structures in the polymer in 2–2.5 times



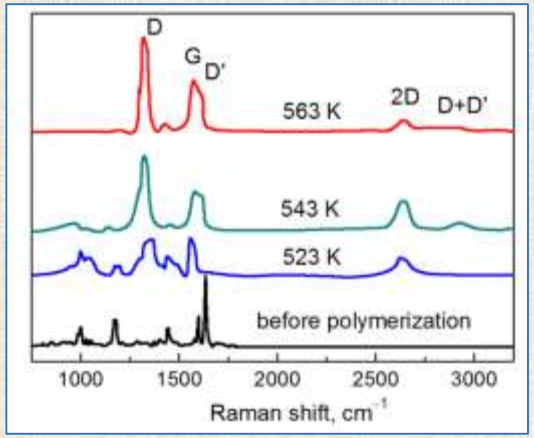
Examples of bonds that can exist between fragments of a hybrid polymer



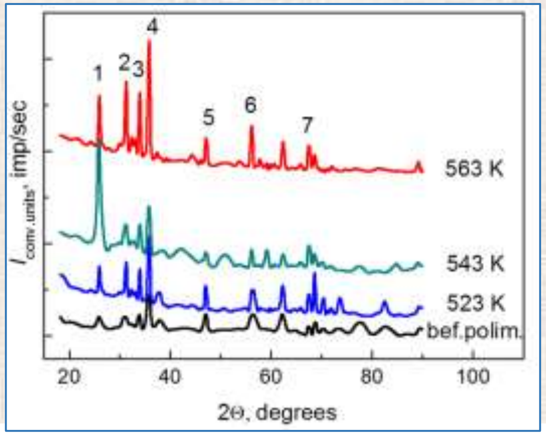
Dependence of the activation energy of the hydrogenation-dehydrogenation processes of organic compounds on the nature of the metal included in the composition of the catalysts of these processes



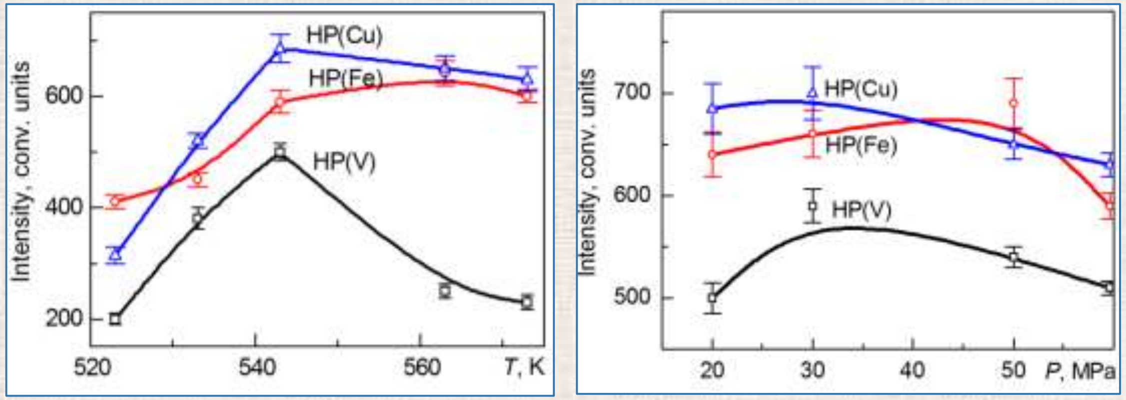
Infrared spectra of vanadium polyphenolates before polymerization and after polymerization at *T* 523, 543, 563 K. The graphene oxide spectrum is also presented



Raman spectra of vanadium polyphenolates before polymerization and after polymerization at temperature 523, 543, 563 K



Diffraction patterns of vanadium polyphenolates before polymerization and after polymerization at *T* 523, 543, 563 K



Change in the number of graphene and graphane structures with an increase of the polymerization temperature *T* and pressure *P* in hybrid polymers based on copper - HP(Cu), iron - HP(Fe), vanadium - HP(V)