The magnitude of nickel crystals depends on the leaching temperature, for each hydrogenated compound there is an optimal crystal size, which, for example, for the reduction of nitrobenzene is 5.9 nm.[30] The addition of vanadium and copper makes the catalyst more selective, prevents the hydrogenation of the nucleus. Typically, skeletal catalysts operate at atmospheric pressure; in turn, an increase in pressure significantly increases the reaction rate.[21,22,30,31]

Along with Raney nickel other nickel-based catalysts are used, for example, nickel black, nickel catalysts on the different carriers (supports): Ni/Al_2O_3, Ni/C, Ni/kieselguhr, Ni/SiO_2, Ni/ZnO, Ni/MgO, $Ni-Cr_2O_3/C$.[24,25,28,31-34]

It was experimentally proved that the activity of a nickel catalyst is determined by the surface structure on which crystallites with an interplanar spacing are present: 5.6 Å; for skeletal nickel, peaks 2θ=540 and 2θ=430 correspond to similar crystallites.[20,21,24] An analysis of X-ray diffraction data shows that with an increase in the concentration of supported nickel oxide from 4.7 to 23.2 wt.%, the size of coherent scattering regions (CSR) increases from 70 to 180 Å, and the degree of crystallinity of the supported oxide also increases. After reduction of the catalyst with hydrogen under the selected conditions, the characteristic peaks responsible for nickel oxide become insignificant, reflections responsible for metallic nickel appear. During the reduction of the NiO/SiO_2 samples studied, according to the X-ray diffraction patterns (Fig.-3a,b), 70% of the deposited oxide goes into metallic nickel with structural properties characteristic of the active surface.[24] The character of the distribution of elements on the surface of supported nickel catalysts on silica gel can be judged from the data of X-ray diffraction (Fig.-3a,b) and SEM (Fig.-3c).[20,21,24]

The hydrogenation of m-dinitrobenzene to m-phenylenediamine on bimetallic Ni-Pt/C catalysts was studied and a high hydrogenation rate and an almost 100% selectivity for m-phenylenediamine were shown.[35] The hydrogenation efficiency of bimetallic catalysts is higher than that of monometallic nickel catalysts. XRD and XPS data prove that the bulk of nickel in the monometallic catalyst is in the form of Ni^{2+}, while the addition of platinum to nickel stabilizes the state of NiO.

Catalysts on the Base of Fe

In recent years, the attention of researchers has increasingly been attracted to the study of the reduction of organic compounds with various functional groups in the presence of iron-containing catalyst systems to decrease the cost of catalysts and less use of expensive noble metal catalysts.[36-40]

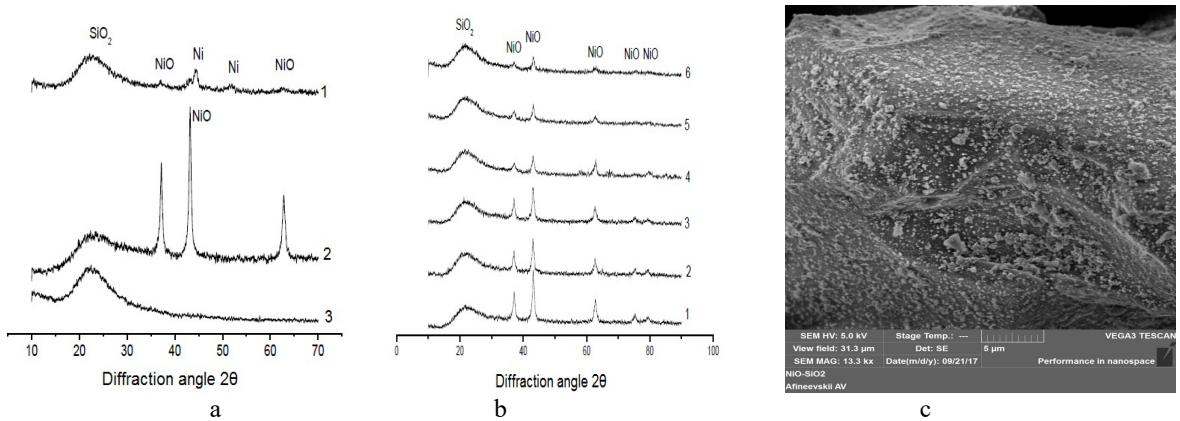

Fig-3: X-ray Diffraction Patterns of the Catalysts (a, b): (a) 1 - Pure Silica Gel; 2- 23.2 wt.% Deposited Nickel (in the form of oxide); 3 - Reduced Catalyst, 11 wt.% of deposited Metallic Nickel; (b) Deposited oxide Nickel on Silica Gel, with a concentration of wt. %: 1-11; 2-10; 3-9; 4-5; 5-4; 6-0.6; (c) SEM Image of a supported Nickel Catalyst[24]

Of particular interest are Fe nanoparticles and their oxides, as well as bimetallic particles based on them. This is due to the prevalence of Fe in the earth's crust, low cost, non-toxicity. Also, iron-containing catalysts can exhibit magnetic properties. Due to its pronounced magnetic properties, Fe_3O_4 is most often