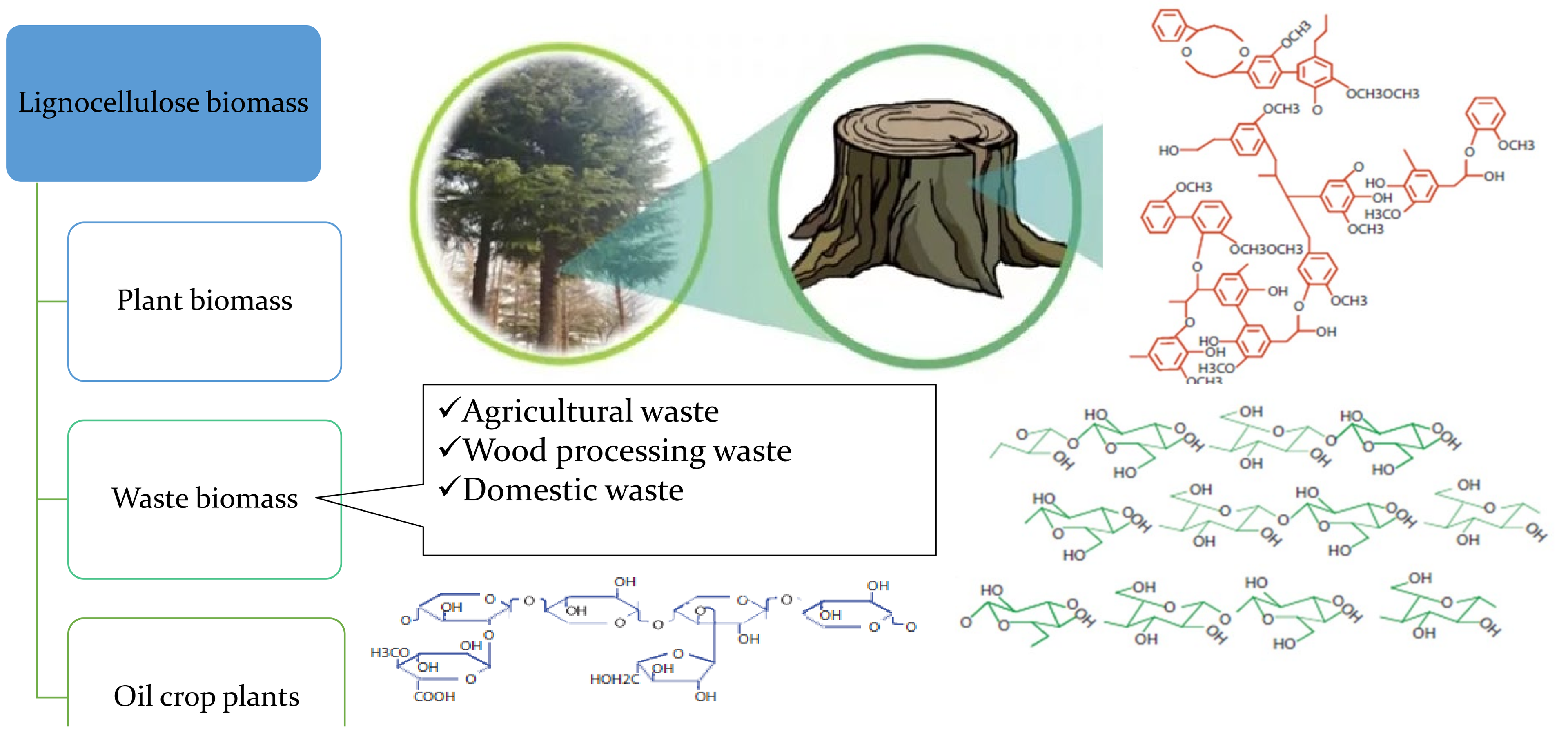
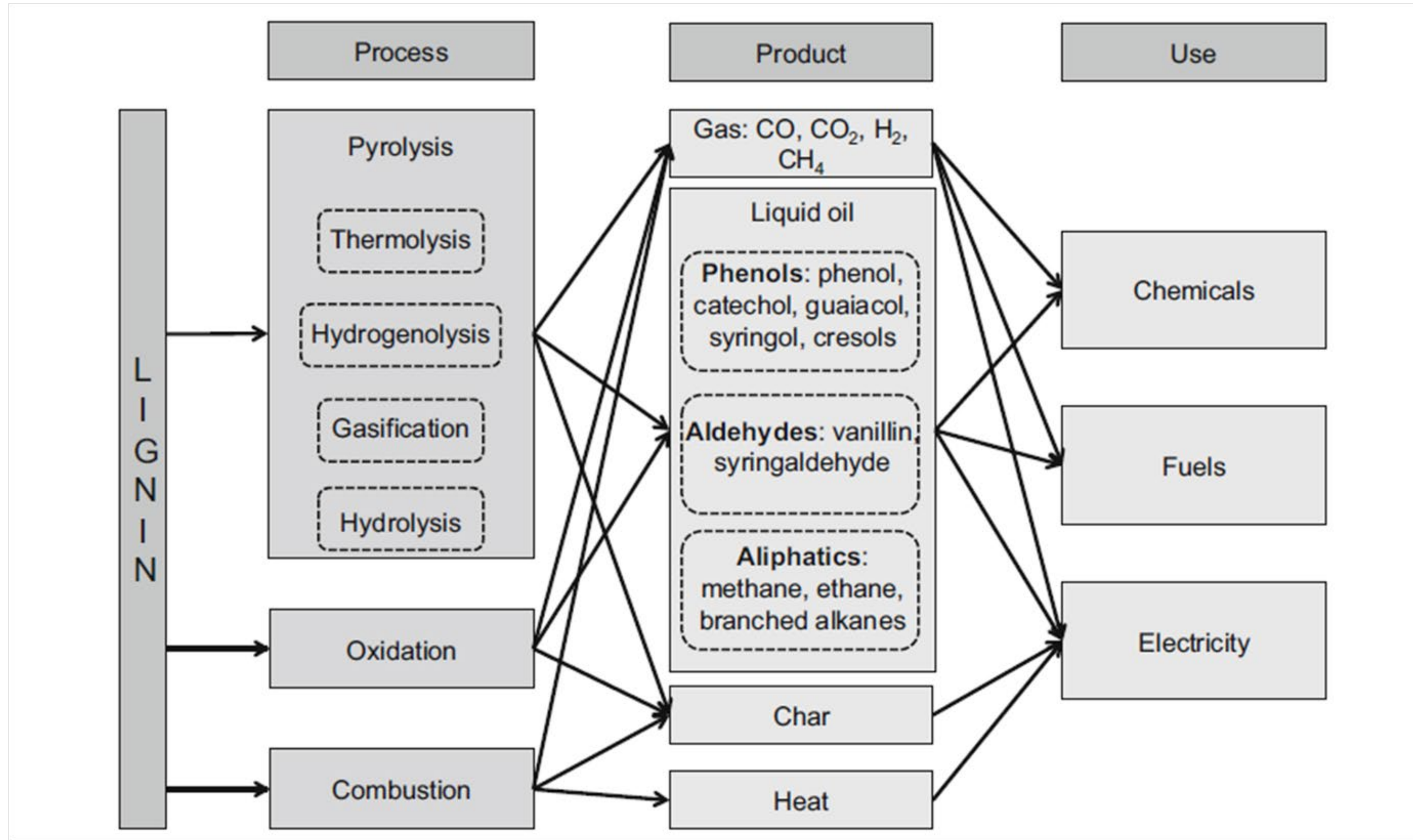
Tver State Technical University

# Lignin Valorisation in the Presence of $SiO_2$@Polymer Supported Catalysts

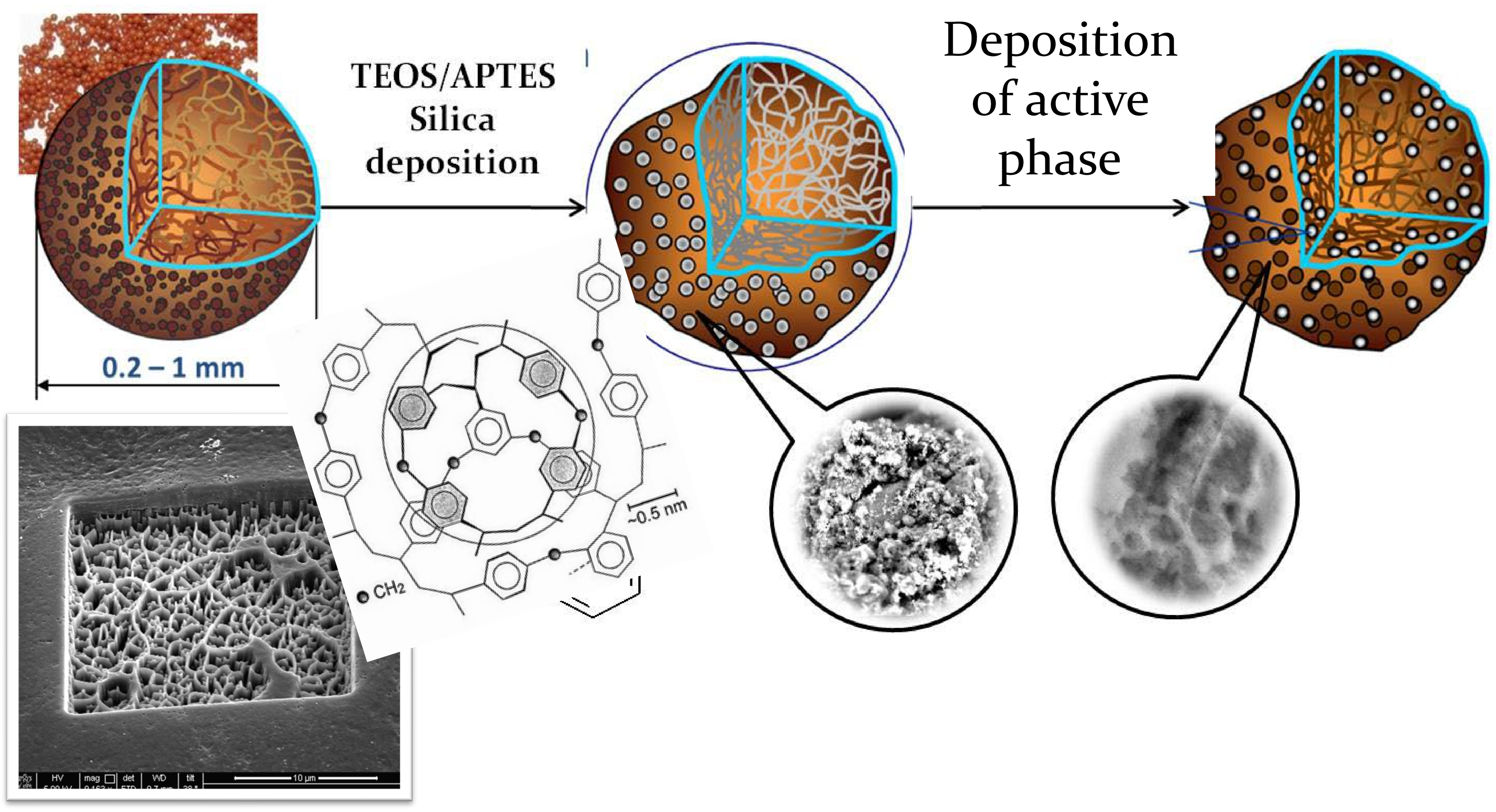
Stepacheva A.A., Markova M.E., Manaenkov O.V., Sulman M.G




## THE MATRIX OF THERMOCHEMICAL LIGNIN TRANSFORMATION PROCESSES




*Pandey M.P., Kim C.S. (2011) Lignin depolymerization and conversion: a review of thermochemical methods. Chem Eng Technol 34:29

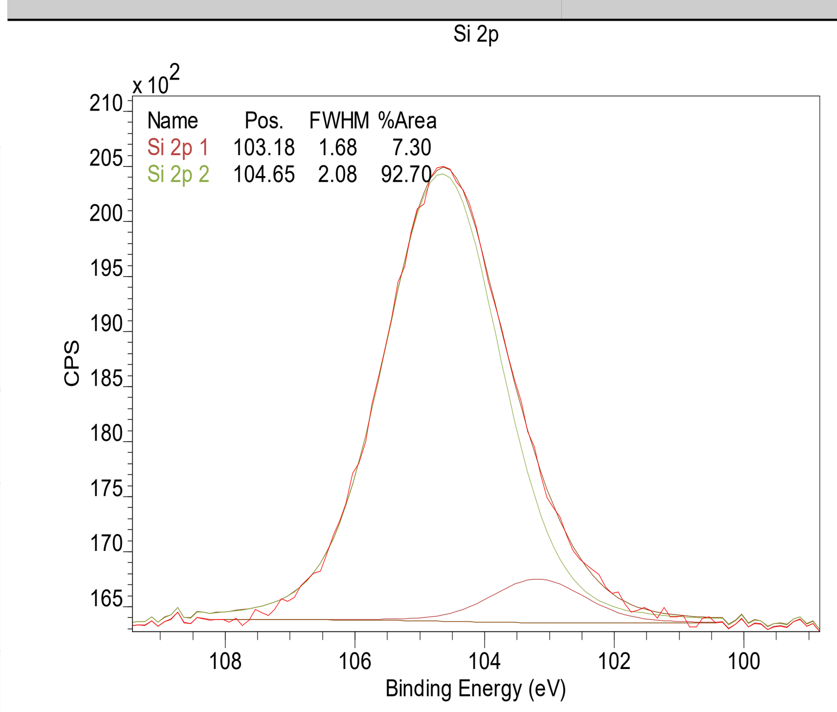



## BET study of support

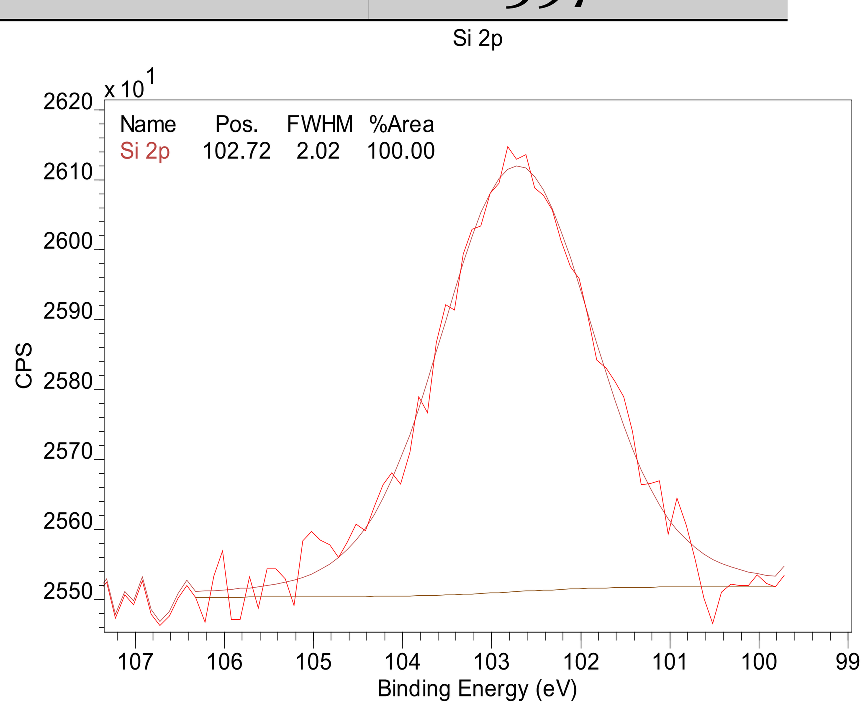
| Sample | $V_{pores}$, $cm^3/g$ | $S_{BET}$, $m^2/g$ | t-plot surface area, $m^2/g$ |
|---|---|---|---|
| HPS (MN-100) | 0.52±0.01 | 814±1 | External 208±1 Micropore 696±1 |
| $SiO_2$@HPS as synthesized | 0.40±0.01 | 611±1 | External 197±1 Micropore 435±1 |
| $SiO_2$@HPS after heating | 0.65±0.01 | 951±1 | External 380±1 Micropore 597±1 |

## Catalyst characterisation

| Sample | $S_{BET}$, $m^2/g$ | Metal compound* | $D_m$, nm | Total acidity, μmol/g |
|---|---|---|---|---|
| Ni-$SiO_2$@HPS | 584±1 | NiO | 17.4±0.2 | 965±5 |
| Ni-$SiO_2$@HPS after reaction | 521±1 | NiO, Ni | 21.3±0.2 | 782±5 |
| Ru-$SiO_2$@HPS | 736±1 | $RuO_2$ | 5.2±0.1 | 903±5 |
| Ru-$SiO_2$@HPS after reaction | 694±1 | $RuO_2$, Ru | 5.2±0.1 | 726±5 |
| Ni-Ru-$SiO_2$@HPS | 628±1 | NiO, $RuO_2$ | 6.3±0.1 | 942±5 |
| Ni-Ru-$SiO_2$@HPS after reaction | 589±1 | NiO, $RuO_2$, Ni, Ru | 6.4±0.1 | 788±5 |

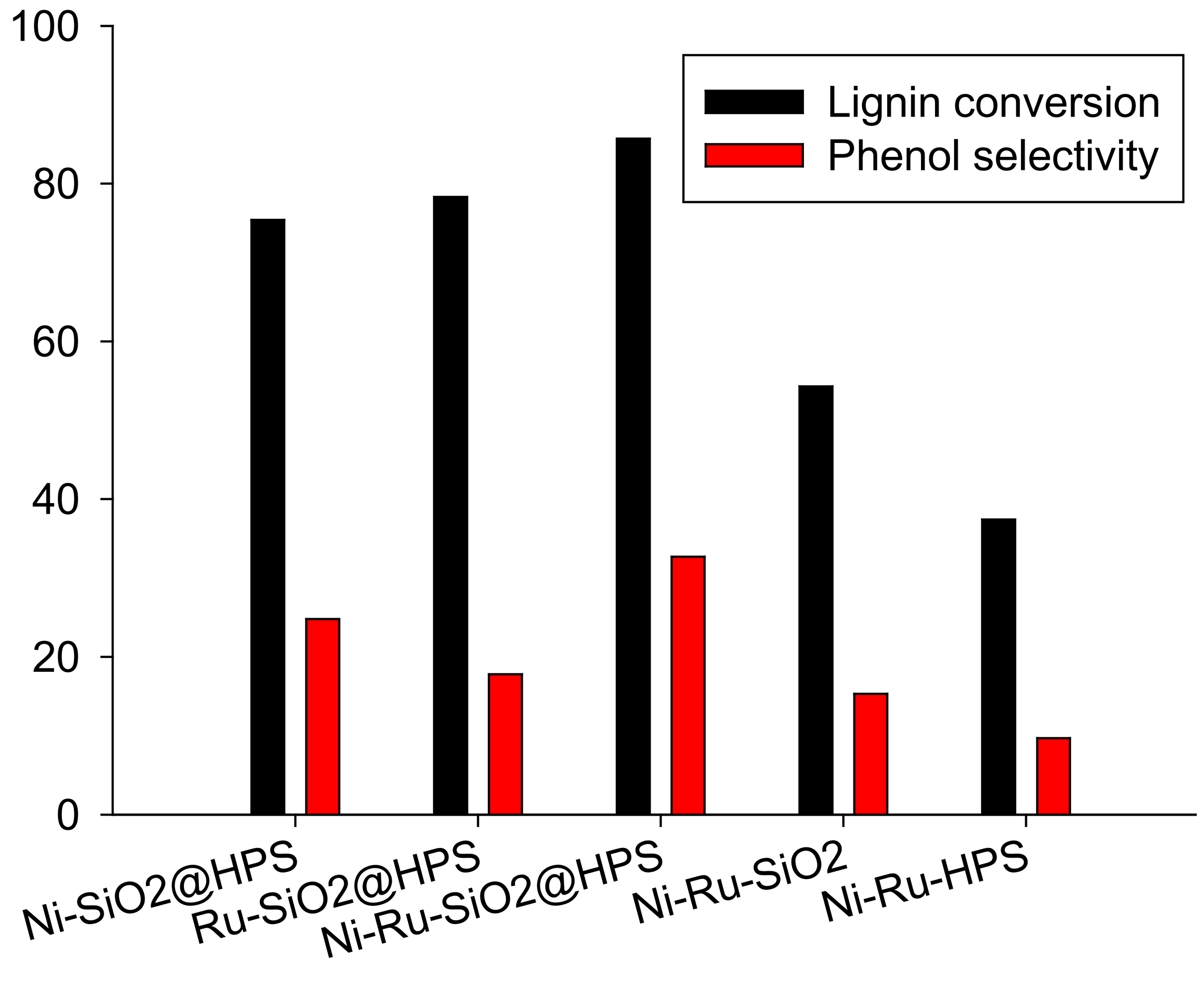


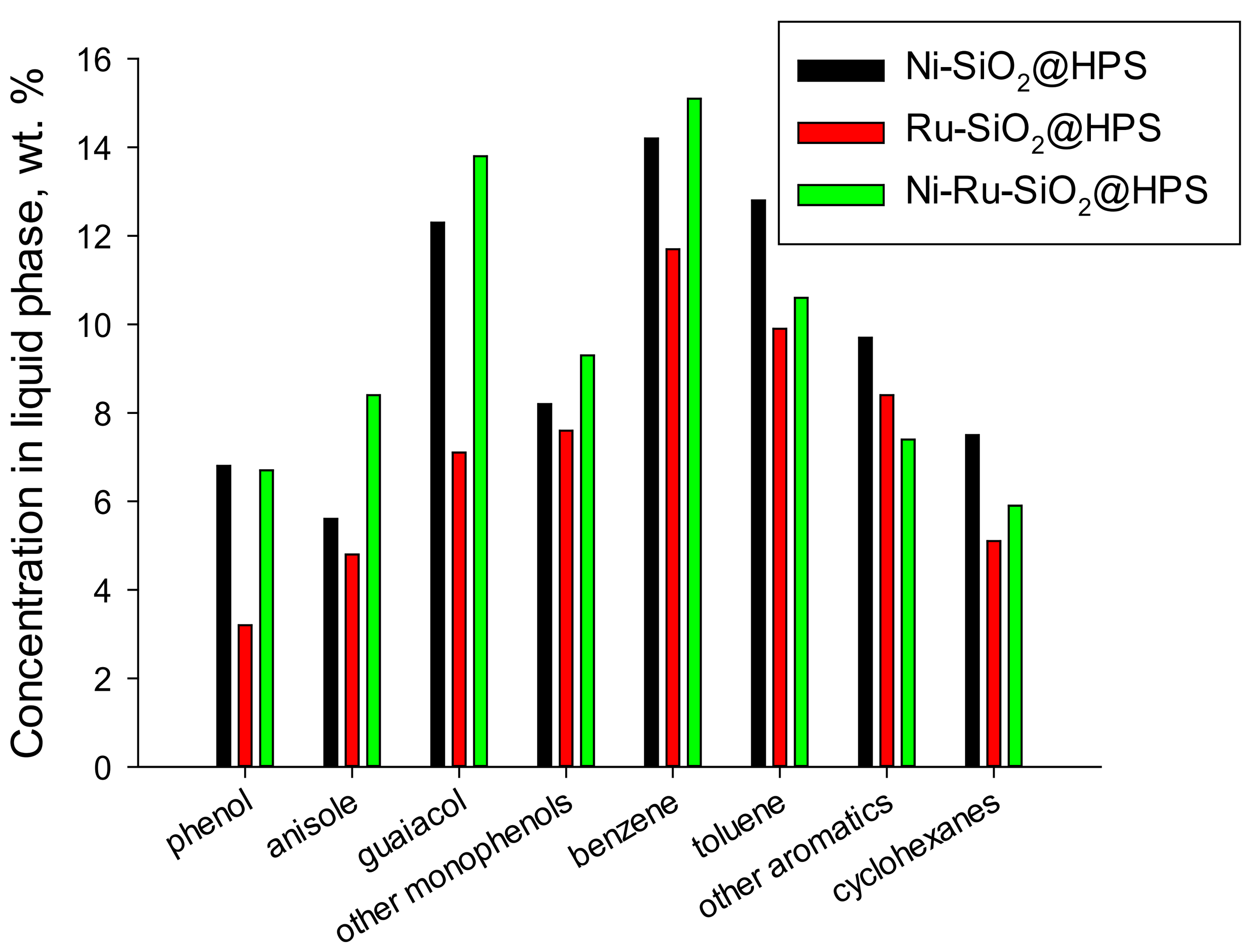

$SiO_2$@HPS as-synthesised

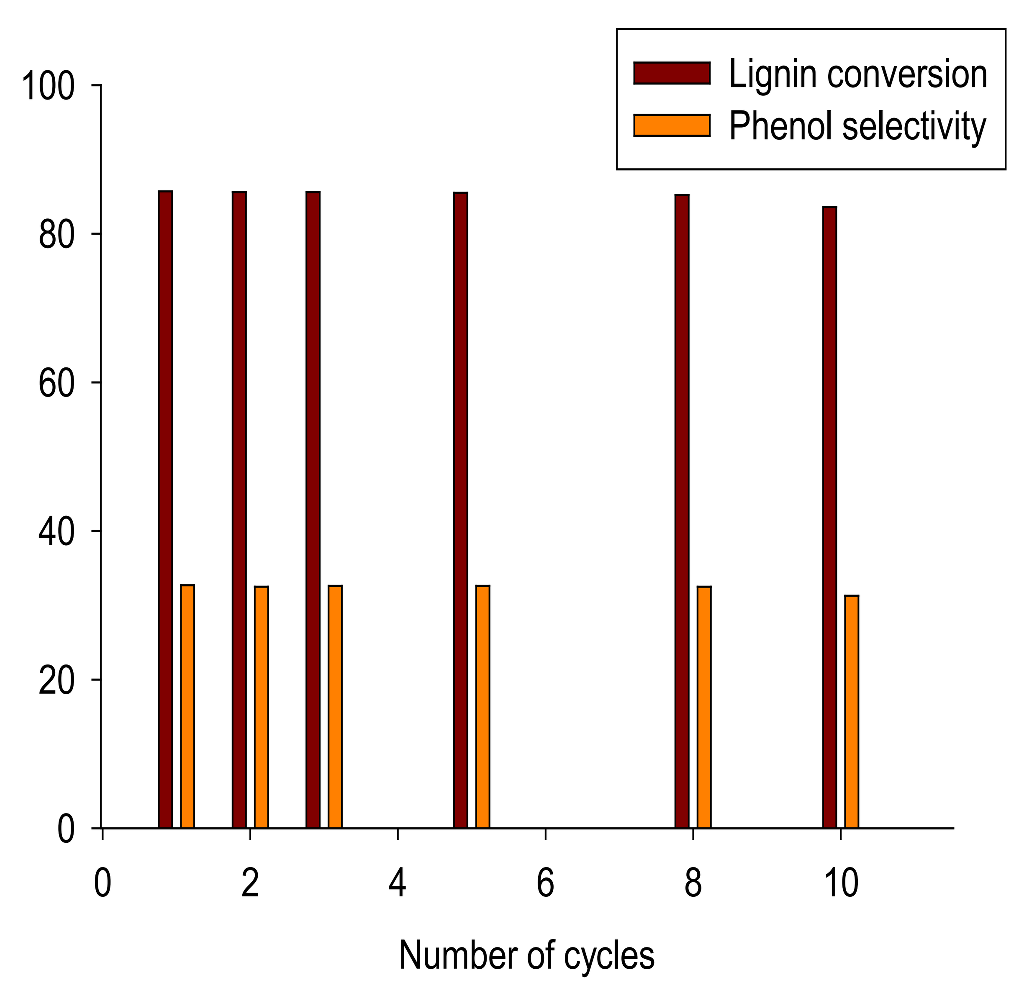



$SiO_2$@HPS after heating

| Sample | Elemental composition, wt. % | | | | |
|---|---|---|---|---|---|
| | C | O | N | Si | Cl |
| $SiO_2$@HPS as synthesized | 86.2±0.3 | 6.9±0.1 | 3.1±0.1 | 2.8±0.1 | 1.0±0.1 |
| $SiO_2$@HPS after heating | 83.8±0.3 | 8.7±0.1 | 0.6±0.1 | 6.0±0.1 | 0.8±0.1 |




The best catalyst was found to be a bimetallic Ni-Ru-$SiO_2$@HPS, which showed high lignin conversion (up to 95 %) and the monophenol yield (42 wt. %) under optimized reaction conditions. The catalysts demonstrated a remarkable stability in 10 consecutive runs without any loss of active phase.

The financial support for the work was provided by the Russian Science Foundation (grant 22-79-10096).