

## **Synthesis of pyranopyrazoles using magnetically recyclable heterogeneous iron oxide-silica core-shell nanocatalyst**

### **Abstract**

The  $\text{Fe}_5\text{O}_4@\text{SiO}_2$  core-shell nanocatalyst were prepared and efficiently used for four-component coupling reaction of aromatic aldehydes, malononitrile, ethyl acetoacetate and hydrazine hydrate in water/ethanol mixture. Various aromatic aldehydes possessing electron-withdrawing and electron-donating groups in different positions on the ring were successfully transformed to substituted pyranopyrazoles in high yields in short time. The nanocatalyst was easily recovered, and reused five times without significant loss in catalytic activity and performance. The structure, size and morphology of the nanosized catalyst were studied by various techniques such as Fourier transform infrared spectroscopy, powder X-ray diffraction, dynamic light scattering and transmission electron microscopy.