Chemists develop method to obtain catalyst-, surfactant- and template-free polymeric nanoparticles

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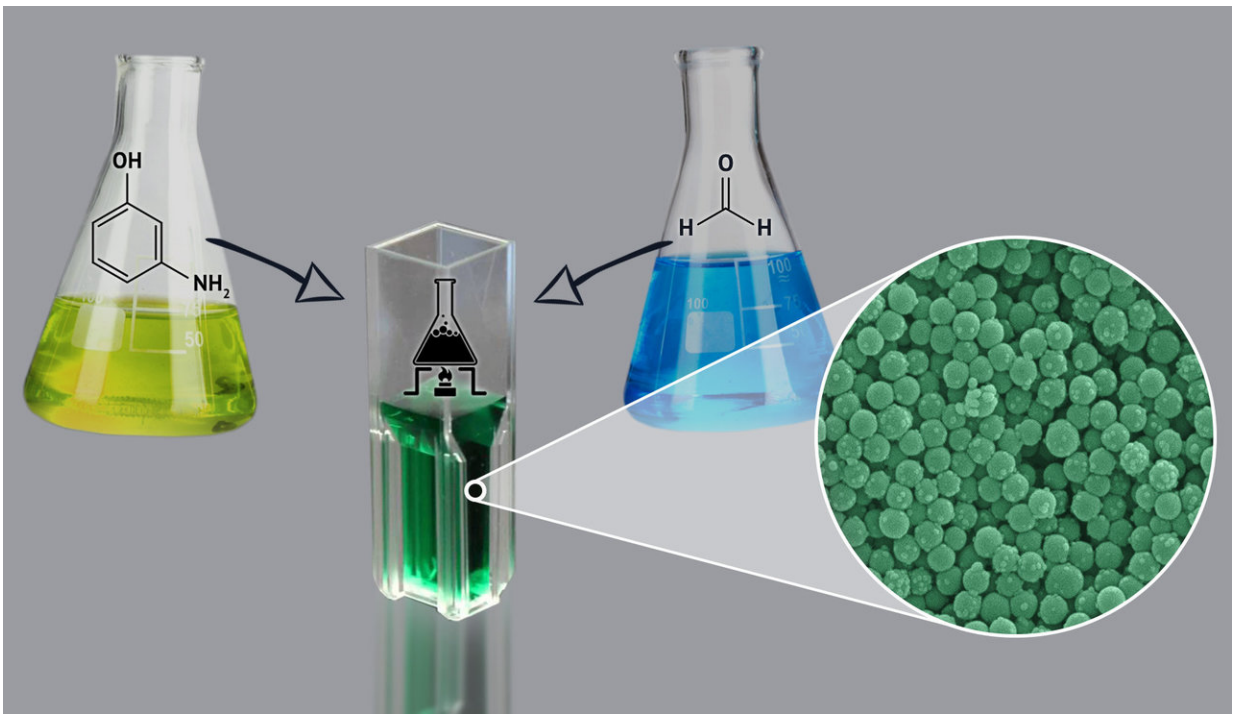

Reaction developed by RUDN chemists contains two monomers - 3-aminophenol and formaldehyde. Credit: Allen Dressen

A chemist from RUDN proposes a simple technology for producing polymeric nanoparticles from only two organic substances. By changing the temperature of the reaction and the ratio of initial substances, the

scientists can obtain particles of any given size. The new method was described in *Macromolecules*.

To create nanoparticles of identical size and shape, laboratories all over the world have been using the synthesis of benzonaxine group polymers from different monomers. Usually, polymerization and formation of homogeneous nanoparticles require special templates, catalysts and additions. Rafael Luque, a visiting scholar at RUDN, together with his colleagues from China and Pakistan, suggested a simple method for obtaining nanoparticles.

The reaction developed by RUDN chemists contains two monomers—3-aminophenol and formaldehyde. 3-aminophenol is an aromatic amine and also an aromatic alcohol, as it possesses both a phenol group and an amino group. Taking this dual structure into account, the researchers carried out polymerization without additional components.

Formaldehyde was added to a 3-aminophenol solution in water and ethyl alcohol. Then the mixture was stirred at moderate temperature (up to 75° C). After that, centrifugal separation was used to extract polymeric nanospheres of identical form and size. Such nanoparticles may become the basis for carbon nanoparticles that are in higher demand. The chemists obtained them by baking the nanoparticles under a nitrogen stream. The particles showed high thermal stability and preserved their spherical form.

The new technology is interesting because it allows researchers to manage the size of the synthesized structures easily. The higher the concentration of 3-aminophenol in the solution, the bigger the nanospheres. Having repeated the experiment several times, the scientists managed to synthesize the particles with diameters ranging from 372 to 1,030 nm.

"The method developed in collaboration with our Chinese colleagues can be potentially scalable for industrial use," says Rafael Luque, director of the Center for Molecular Design and Synthesis of Innovative Compounds for Medicine, and a visiting scholar at RUDN. "We've developed a simple and comparatively cheap procedure for obtaining polymeric nanospheres at low temperatures without catalysts, surfactants and or templates. It can be applied in different areas. Polymeric nanospheres and nitrogen-containing carbon nanoparticles based on them may be used for catalysis, energy conversion and storage, purification of other substances, and so on."

More information: Jianming Zhao et al. Autocatalysis Synthesis of Poly(benzoxazine-co-resol)-Based Polymer and Carbon Spheres, *Macromolecules* (2018). DOI: 10.1021/acs.macromol.8b01239

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