Lignin-based multiwall carbon nanotubes

Objective

The objective of this work was to produce carbon particles of spherical, sub-micron beads obtained from Kraft lignin, and to characterize them through Transmission Electron Microscopy in combination with Energy-Dispersive X-ray analysis (TEM-EDX).

Sample Preparation

Kraft lignin (Indulin AT)-derived nanospheres were subjected to thermostabilization and subsequent carbonization in an inert atmosphere up to a temperature of 2000 °C. The resulting carbon powder was prepared by dispersion onto TEM carbon support grids for its analysis.

Data acquisition

TEM imaging was performed using a CS-corrected FEI Titan Themis equipped with a Wien filter monochromator. The microscope was operated at accelerating voltage of 60 kV with excited monochromator. Images were taken under slight defocus at short exposure times with a Ceta CMOS camera. Collection of energy-dispersive X-ray spectroscopy (EDX) maps was performed in scanning TEM mode at accelerating voltage of 200 kV with a beam current of 0.5 nA. The data was treated using built-in standards in FEI Velox software.

Representative figures & Results

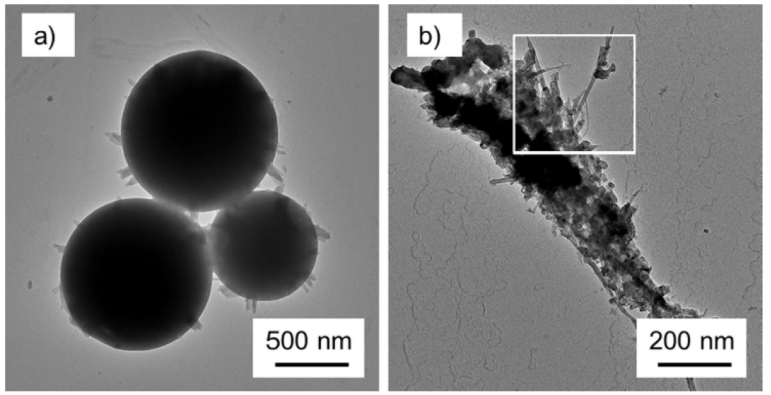

Fig. 2. a) Lignin-derived spherical carbon particles, b) irregularly shaped graphitic structures emerging from the surface of the spherical carbon particles.

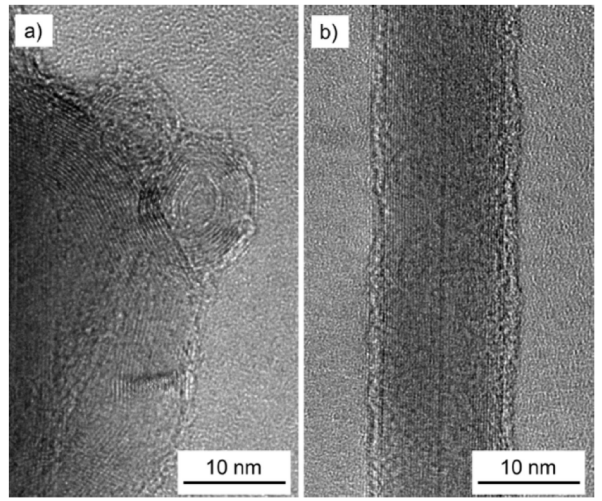

Fig. 3. a) Irregular-shaped and multiply kinked multilayer carbon structures, and b) well-aligned multiwall carbon nanotube.

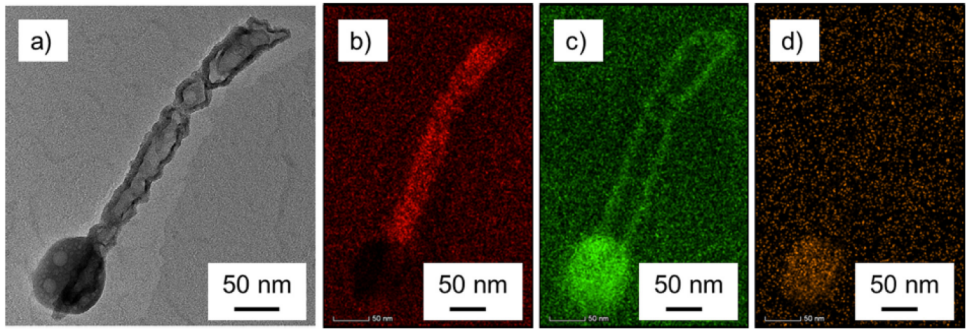

Fig. 5 (a) TEM image of a multiwall carbon nanotube emerging from a spherical structure together with TEM-EDX element maps for b) carbon, c) oxygen, and d) magnesium.

Conclusion

The high temperature in carbonization experiments of lignin induces the segregation of inorganic impurities already present in lignin (as magnesium) into metal nanoparticles capable of catalyzing the growth of carbon nanotubes. The carbon nanostructures found in the present study are of significant interest with regard to potential novel synthesis pathways of bio-based carbon and high-value materials derived thereof.