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Laser synthesis of ultra-small Fe nanoparticles influenced by various liquid environments

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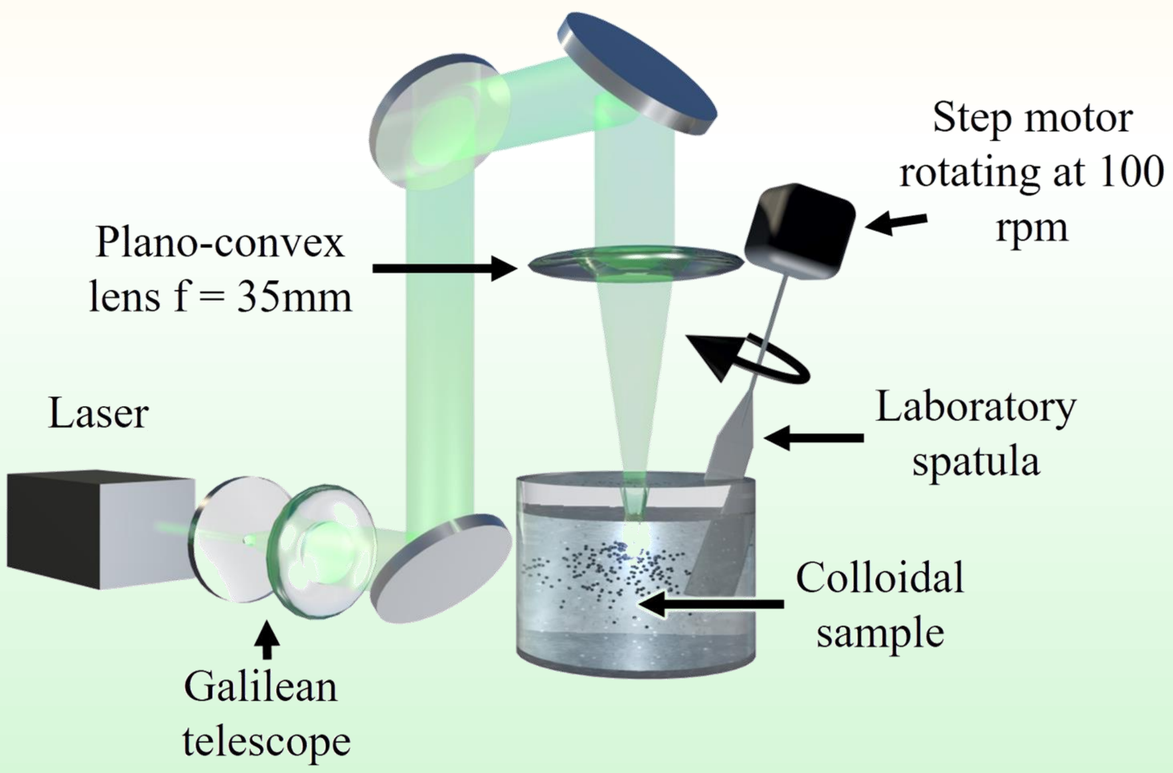
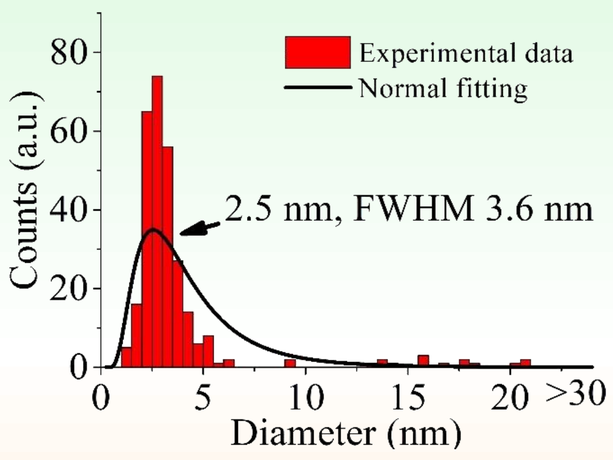
In this work, laser fragmentation in liquids (LFL) is exploited to produce highly pure and stable iron ultra-small nanoparticles. The versatile synthesis is done by reducing the size of carbonyl iron microparticles dispersed in different solvents. The final colloids include bare 3 nm in size Fe-based (Fe, FeOx or FeC) nanoparticles with high Zeta potential value. The whole process avoids chemical waste generation or hazardous chemicals use, and thus, the described methodology represents a green chemistry alternative to all wet chemical methods. Besides, the lack of ligands on nanoparticles' surfaces can be advantageous for applications, which requires many chemically active sites, e.g., catalysis. The present route represents a promising methodology for the preparation of new-generation nanomaterials with precisely defined chemical structures.

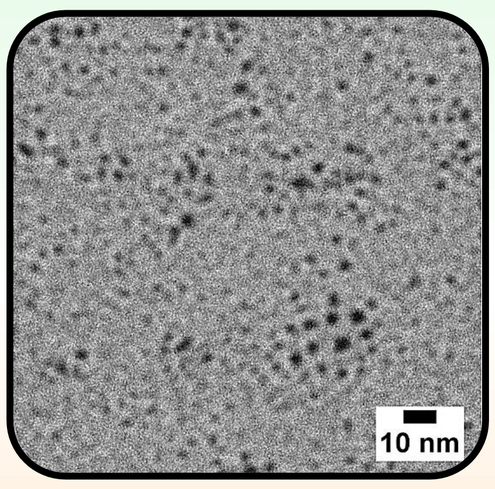
Experiment



Nanoparticles

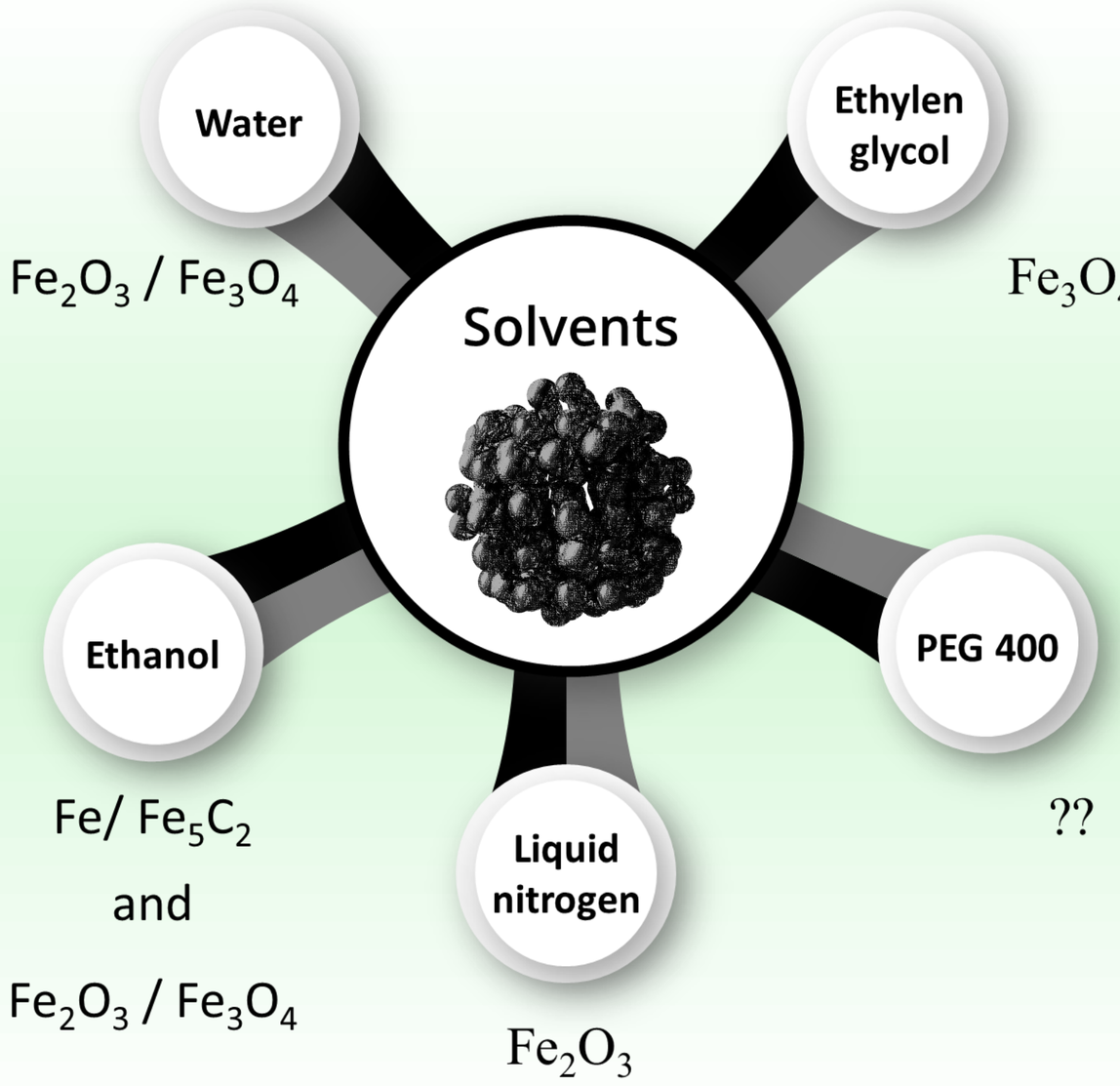


Ethylen glycol



Nano-characterization

Chemical composition based on XPS and SAED analysis



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Conclusions

In summary, the research proves that the methodology of laser fragmentation in liquids (LFL) can be employed to synthesize ligand-free ultra-small iron nanoparticles in solvents with different dipolar moments. Moreover, it also reveals that the solvent's selection can enable precise control over the nanomaterial's chemical structure and production rate. Since this work brings new insights to the waste-free production of extremely small materials with controlled surface and composition, the current findings will be of fundamental interest to the scientific community involved in the materials and nanoscience fields.

Acknowledgement

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Reference

[1] HAVELKA, Ondřej, et al. On the Use of Laser Fragmentation for the Synthesis of Ligand-Free Ultra-Small Iron Nanoparticles in Various Liquid Environments. Nanomaterials, 2021, 11: 1538.