Fraunhofer IKTS

ECOTOXICOLOGICAL RELEVANCE OF IRON-BASED NANOMATERIALS

Tobias Meißner, Annegret Potthoff
Fraunhofer Institute for Ceramic Technologies and Systems IKTS

Fe Nanosit

Bundesministerium für Bildung und Forschung

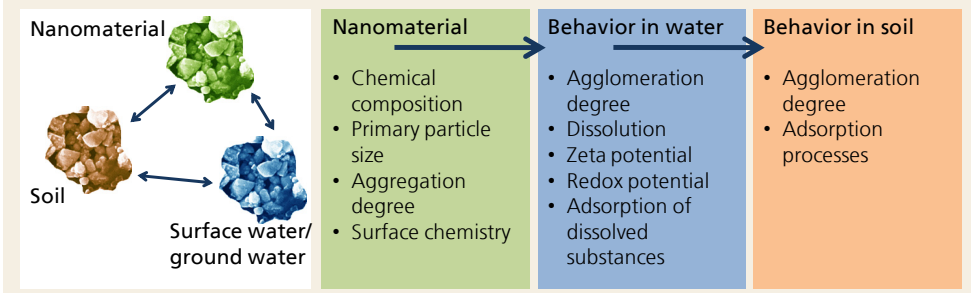
MOTIVATION

Within the German project Fe-NANOSIT a novel nano-structured composite material made of zero-valent iron and activated carbon (Carbo-Iron) is developed. For a deliberate insertion of Carbo-Iron in the environment a risk assessment, including ecotoxicological studies, is necessary.

AIMS

- Development of stable Carbo-Iron suspensions
- Elucidation of interactions between nanoparticles and dispersants
- Assessment of the particle's behavior in ecotoxicological media
- Correlation characterization ↔ ecotoxicological experiments

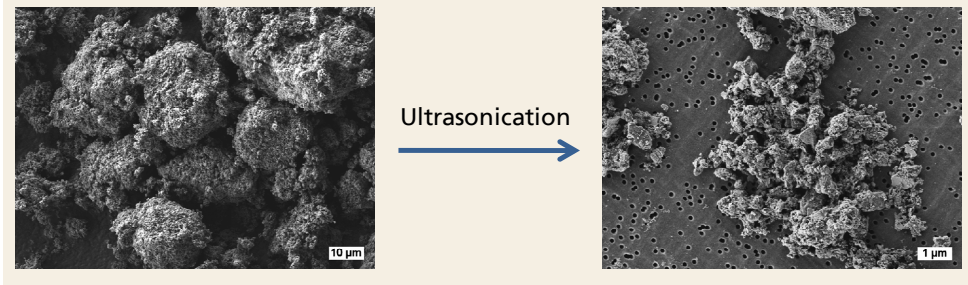
PROCEDURE AND METHODS



RESULTS

- Use of carboxymethyl cellulose (CMC) as dispersant to stabilize Carbo-Iron suspensions
- Dispersing, e.g. by ultrasound, to get suspensions with isolated particles

→ Preparation of suspensions, which are clearly defined in terms of particle size and distribution
  ⇨ Prerequisite for meaningful ecotoxicological investigations



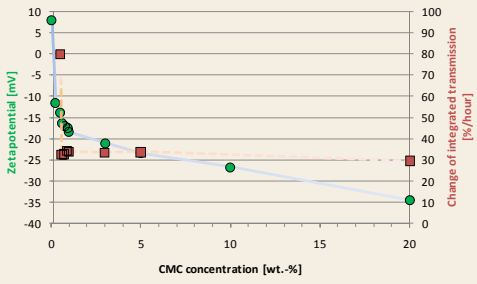
SEM image of Carbo-Iron-particles before and after dispersion.

- Zeta potential measurements to assess electrostatic stabilization

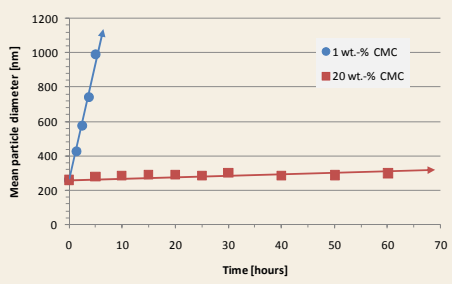
→ Increasing CMC concentration induces decreasing zeta potential values
  ⇨ Improved electrostatic repulsion forces between particles enhance suspension stability

- Analytical centrifugation to consider steric stabilization factors of CMC

→ Less than 1 wt.-% CMC required for stable Carbo-Iron suspensions
  ⇨ Electrosteric stabilization mechanism of CMC with high steric contribution



Zeta potential and sedimentation behavior of Carbo-Iron in H_2O as a function of CMC concentration.



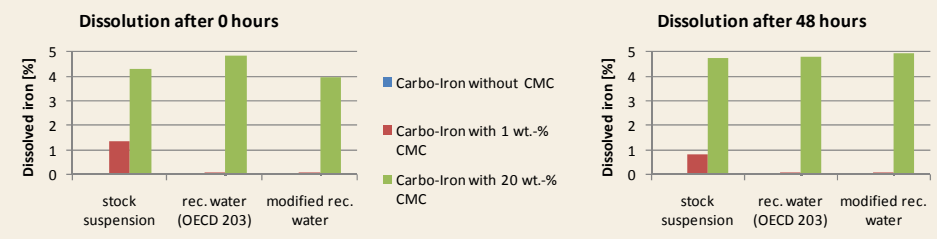
Carbo-Iron (50 mg/l) with different CMC amounts in test media (shown for M7).

- Studying the particle's behavior after addition of Carbo-Iron stock suspension into ecotoxicological test media such as Elendt M4 and M7 (OECD 202, 1994), reconstituted water (OECD 203, 1992) etc.

→ Behavior of Carbo-Iron in test media depends on CMC concentration
  ⇨ Constant particle size over a period of several days is given when taking sufficient dispersant

- Recording dissolubility of iron from Carbo-Iron in stock suspension as well as in ecotoxicological test media

→ Dissolution of iron increases with higher CMC amount
  ⇨ Even at 20 wt.-% CMC low dissolubility of iron and therefore uncritical for water organism



Dissolution behavior of iron from Carbo-Iron. Concentration stock suspension 1 g/l; test media 100 mg/l.

CONCLUSION

- Electrosteric and sedimentation stability of Carbo-Iron particles in suspension and dissolubility of iron depend on the concentration of the dispersant carboxymethyl cellulose (CMC).
- For interpretation of ecotoxicological test results a complex characterisation of particles in media is necessary.

Acknowledgments

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