A convenient alternative to liquid argon for IUPAC- recommended gas sorption analyses

3P INSTRUMENTS — Characterization of particles · powders · pores

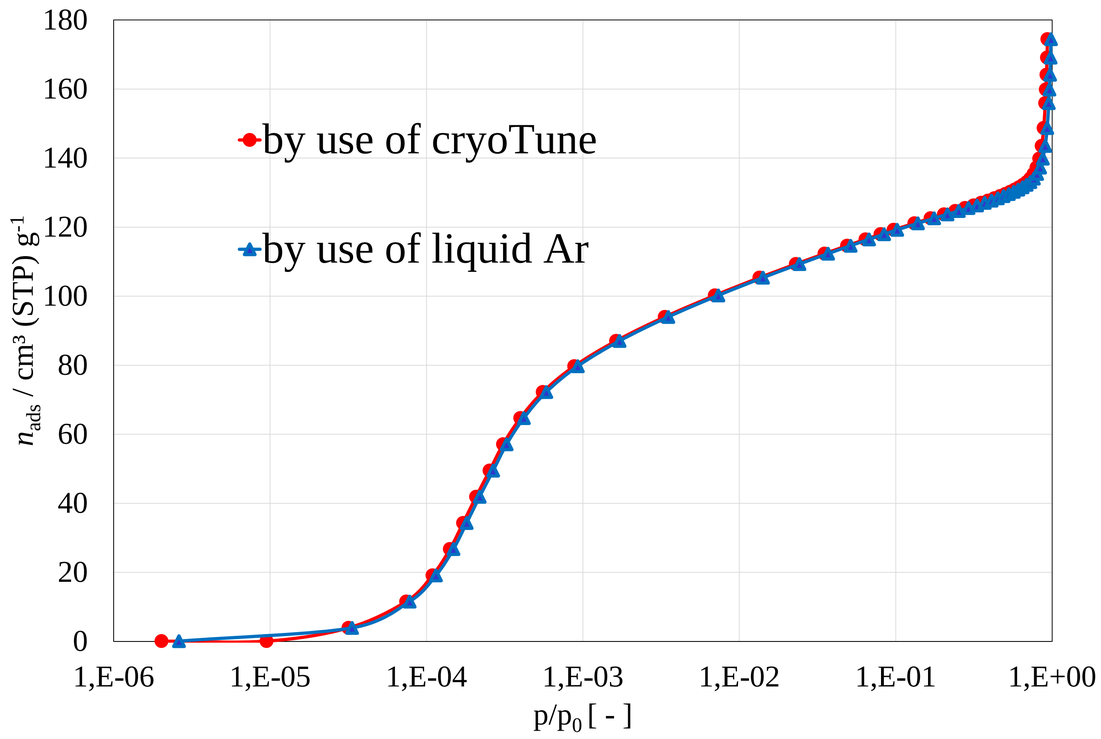
Applications

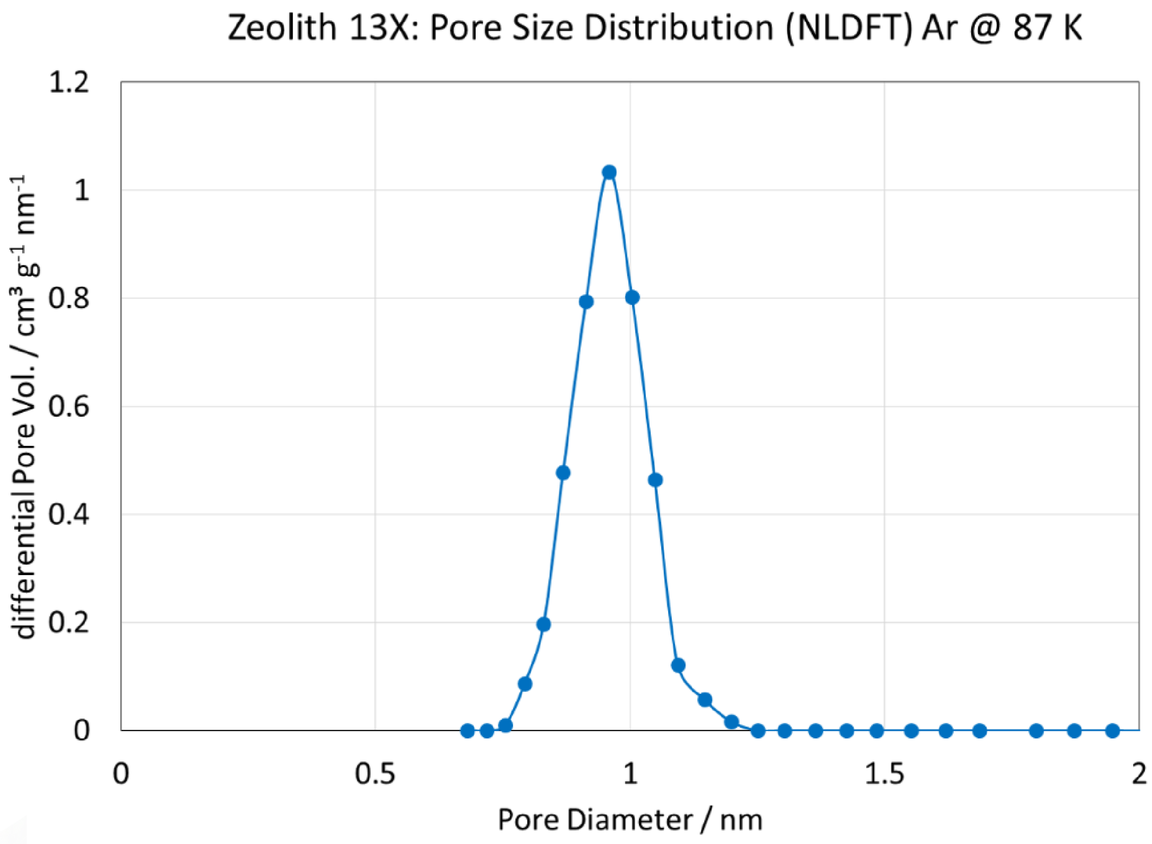
- Material Research
- MOF's / Hybrid Materials
- Chemical Engineering
- Zeolitic Materials
- Gas Separation
- Carbons
- Environmental
- Batteries / Fuel Cells

The advantage of argon- over nitrogen physisorption in micropore analysis

It is well established (see the norm ISO 9277 and the latest IUPAC recommendations in Pure. Appl. Chem. 87 (2015) 1051)) that argon provide distinct advantages over nitrogen molecules for gas sorption analyses, including the following:

- Unlike nitrogen, argon has no quadrupole moment. Thus, using argon as adsorbate eliminates specific chemical interactions with polar/ionic surface sites
- As a result, argon physisorption isotherms provide much more reliable fingerprints of the interactions modeled by today's most advanced techniques for pore size characterization
- Argon sorption analyses at its boiling point (87 K) can be significantly faster than conventional N_2 77 K experiments, because the filling of similar pores can occur much more readily at much higher relative pressures





cryoTune

- Low-Cost Cryogenic Temperature Controller for Gas Sorption Analyzers
- Available for all gas sorption analyzers
- Measuring between 83 K to 135 K
- by use of liquid nitrogen
- > 48 h dewar hold time
- at 87.3 K
- easy handling
- without noise
- very low energy consumption

cryoTune features

- Performs analyses at liquid argon temperature (87.3 K) using less expensive liquid N_2 (77 K)
- Allows Heat of Adsorption calculations by measuring at different temperatures
- Adsorption experiments at the boiling point of other gases, such like O_2 (90 K), Kr (120 K), Methane (112 K)
- Temperature stability better than ± 0.005 K
- Ideally suited to synchronize the need for liquid-argon-free analyses with IUPAC-recommended high resolution micro pore analyses using argon gas at liquid argon temperature (87 K)

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The cryoTune for micropore size analysis and for BET studies of non-micropore materials

3P INSTRUMENTS — Characterization of particles · powders · pores

Applications

- ceramic powders
- MOF's and COF's
- alumina
- zeolites
- silica
- active carbons
- soils
- porous polymers

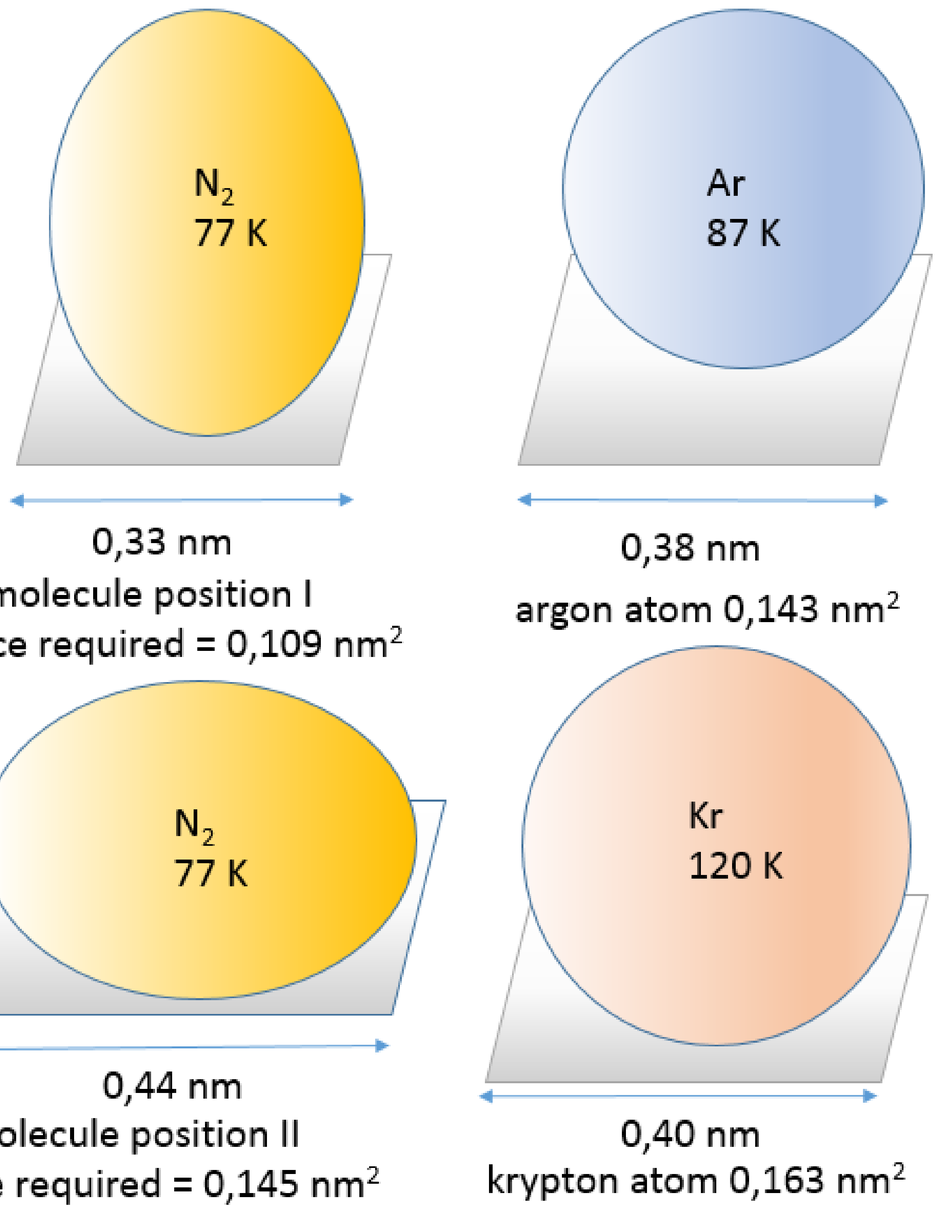
The advantage of argon- over nitrogen physisorption in BET analysis

Additionally to the micropore characterization, the argon atom has specific advantages according the ISO 9277 and the latest IUPAC recommendations from 2015 over nitrogen molecules for BET surface area studies

- The argon atom has because a spherical shape and so only one position, the place of the argon adsorbate atom does not depend on specific interactions as it is in the case of the ellipsoidal nitrogen molecule
- The quadrupole moment of the nitrogen molecule shift the p/p_0-range of the surface coverage to lower relative pressure and increases the BET-value

BET-Comparison areas from argon 87 K and krypton 120 K with nitrogen 77 K

material	adsorptive	temperature [K]	place for one atom resp. molecule [nm²]	S_{BET} [m²/g]	**S_{BET} N_2 bzw. S_{BET} Kr vs. S_{BET} Ar**
zeolite 13X	Ar	87	0,143	419	
zeolite 13 X	N_2	77	0,162	448	**+ 7 %**
active carbon D55	Ar	87	0,143	637	
active carbon D55	N_2	77	0,162	657	**+ 3 %**
Al_2O_3 5	Ar	87	0,143	4,1	
Al_2O_3 5	Kr	120	0,163	3,7	**- 10 %**
Al_2O_3 5	N_2	77	0,162	5,4	**+ 32 %**
porous glas	Ar	87	0,143	153	
porous glas	Kr	120	0,163	141	**- 8 %**
porous glas	N_2	77	0,162	195	**+ 27 %**
carbon black C6	Ar	87	0,143	65	
carbon black C6	Kr	120	0,163	63	**- 3 %**
carbon black C6	N_2	77	0,162	77	**+ 19 %**



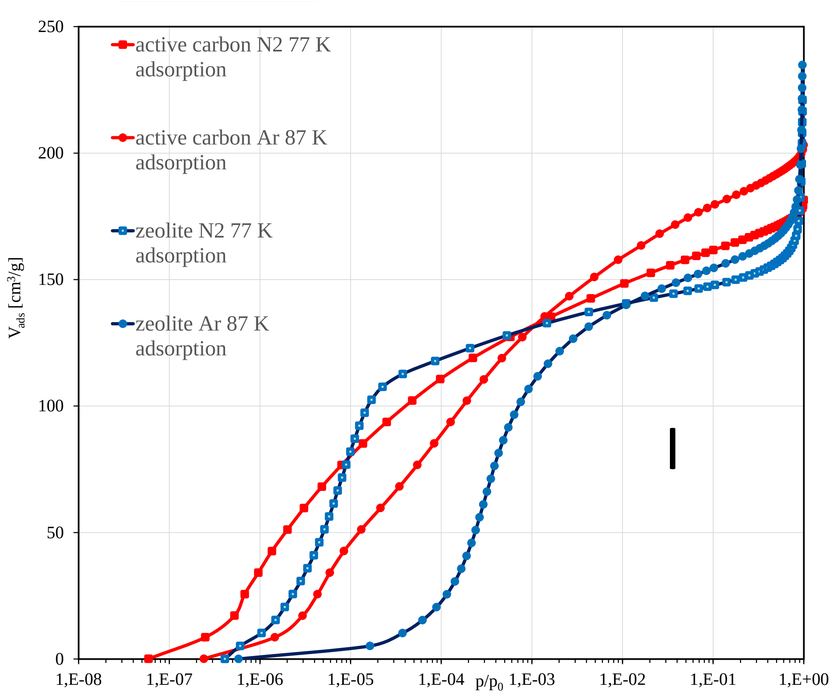
Ways to use the cryoTune:

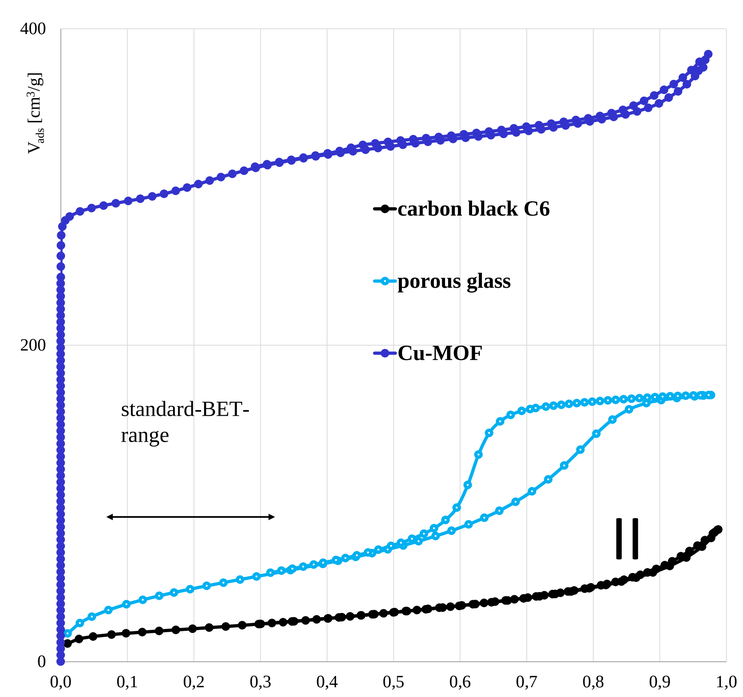
I Ar 87 K isotherms for microporous solids or Kr 87 K isotherms for thin porous layers

II Ar 87 K for BET surface area, pore volume and mesopore size distribution

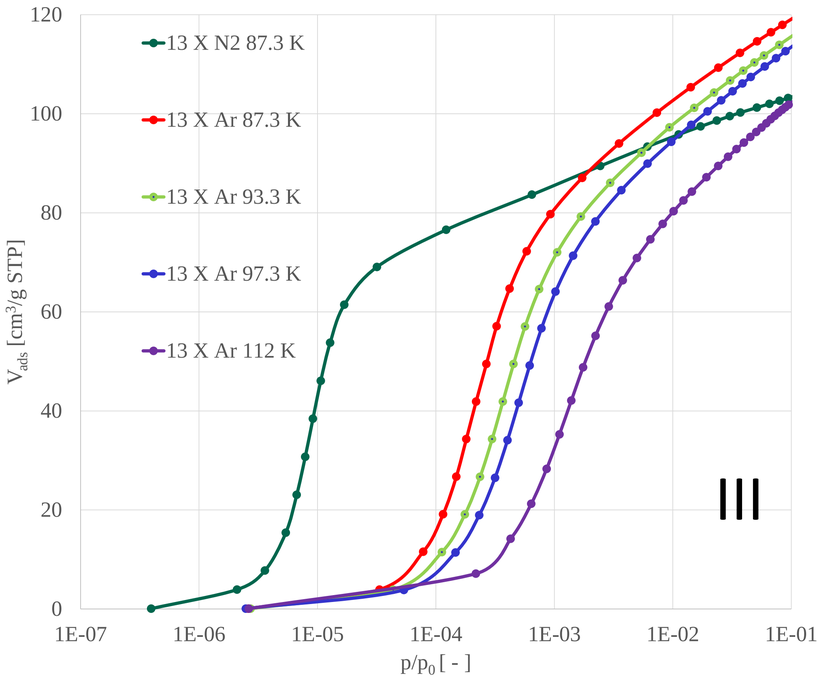
III Ar isotherms at different temperatures, e.g. for calculation of isosteric heat of adsorption (also possible for other gases like N_2, O_2, CH_4)

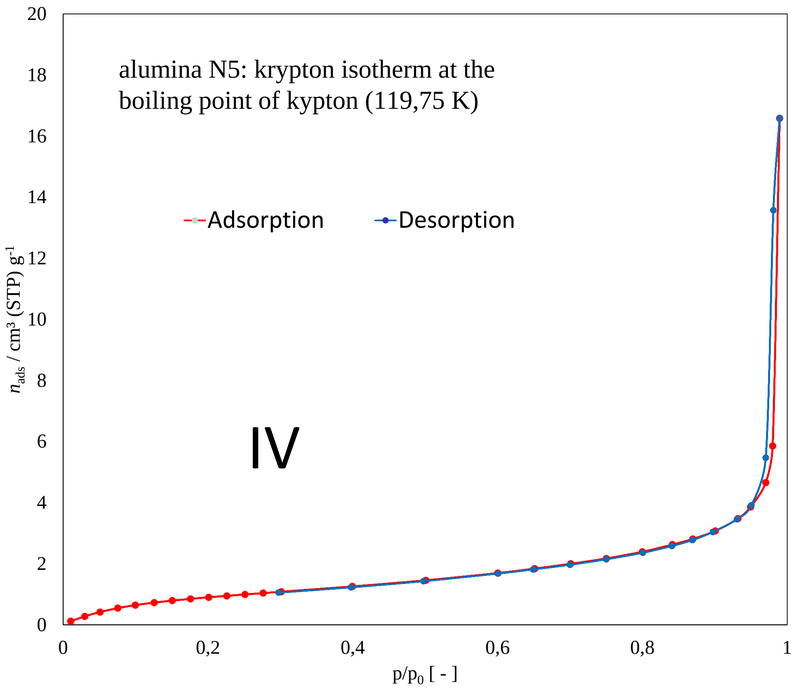
IV isotherms measured at boiling temperatures





for Ar 87 K, O_2 90 K, CH_4 112 K, and Kr 120 K





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