

Nano in de praktijk

TOS

Health, Environment and Safety

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Spinning machine

- Nanospider LAB-M system to spin polymer melts
- This machine creates a melt from the polymer by means of electro-spinning and heating
- It's a closed system, protected with safety elements to prevent intervention of the operators in the technological area of the machine

Mission

- To get more information about the exposure of nanoparticles in the workplace atmosphere

Expecting exposure

- Exposure of very small and long nanofibres near to outlet opening textile
- No understanding of exposure in environment spinning machine

Methods

- Direct reading system: Handy (mobile) ultrafine-particle sensing system (Philips Aerasense NanoTracer) This method is not selective
- Selective measurements by using constant flow air sampling in combination with gold or chrome film coated polycarbonate filters, and analyzing by SEM (this method gives more specific information about the size and kind of nanoparticles, based on NIOSH)
- Infrared Detection of filters
- Röntgenmicro-analyse of filters

Direct Reading

- Handy (mobile) sensing system
- Data logging
- Overall information / Hot Spots
- Measuring range 10 – 300 nm.
- Not selective

Selective measurements

- More specific information about the size and kind of particles
- Distinction between several different particles
- Quantification
- Gold or Chrome film coated polycarbonate filters (resistance in combination with sampling rate) with specific pore size
- Analyzing by SEM (Scanning Electron Microscopy)
- Lowest detection limit is about 30 nm (chrome)

Infrared and/or Röntgen Detection

- Get an spectrum of the product on sampled filter (selective measurement) to compare with product

Strategy

- Starting Research on Monday
- No activities in weekend
- Reference measurements (Direct Reading)
- Calculation selective measurement time depending on results reference measurements
- Selective measurements
- Preparing and Starting up spinningmachine in combination with Direct Reading
- Calculation selective measurements time depending on results Direct Reading
- Selective measurements

Results Direct Reading

- Reference: Stable registration of 5.000 to 6.500 particles/ml in the working room. Particles size about 80 nm.
- After starting the heating about 30.000 till 80.000 particles/ml.
- The particle size changed from about 80 nm to 30 nm
- After starting the spinning machine, concentrations increases to a maximum of about 3.200.0000 particles/ml.
- Hot Spots are determined

Selective Measurements

- There are no fibres detected by the SEM analysis
- There are only a few particles detected by SEM analysis
- Infrared Detection shows a infrared spectrum of particles

Possible explanation

- There is no exposure of fibres and the particle size is too small to catch them with a goldcoated filter of 400 nm (behave like a gas)
- Particle size is too small (< 30 nm) for the roughness of the gold coated filters and therefore not detectable by SEM
- The small particles and/or fibres are not stable or are removed by the vacuum because of the SEM conditions
- The sampled air volume is too low

Lab. Tests

- Filters: Gold coated polycarbonate filters but with a smaller pore size, 20 nm instead of 400 nm
- Filters: Chrome coated filter (which has a smoother surface than the gold coated filters)
Pore size, 20 nm.
- Stability test of product in combination with SEM conditions (vacuum)
- Infrared and/or Röntgen spectrum

Evaluation 1

- The direct reading measurements of the real measurements and simulation lab tests are comparable. Only very small particles detected (coagulation)
- SEM parameters/conditions have no influence on the particles
- Even the surface of the chrome coated filters is too rough to detect particles smaller than about 30 nm.

Evaluation 2

- Even after only heating the system (spinning machine) concentrations of direct reading system were increasing (only small sublimated gas molecules are present)

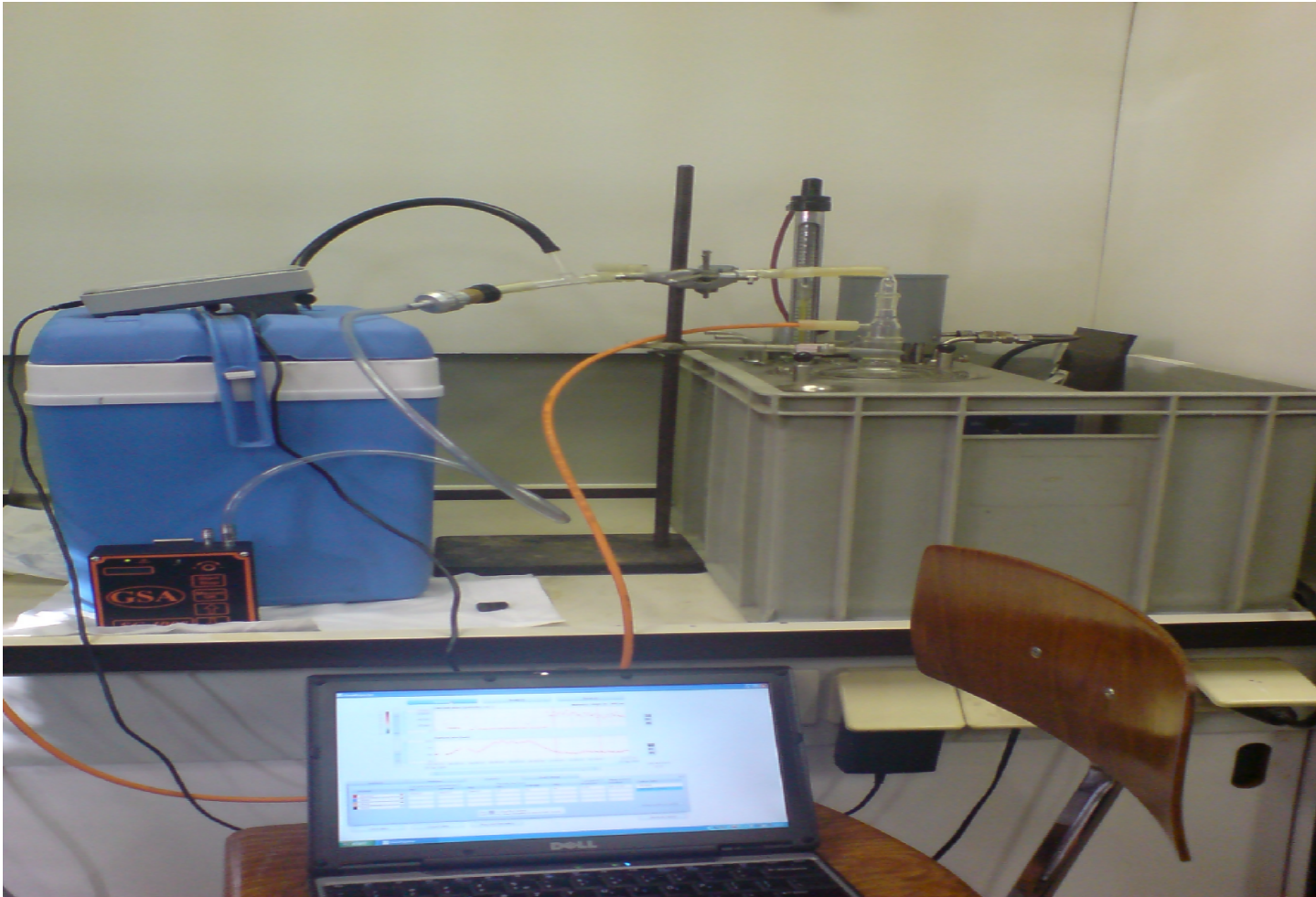
Overall

Based on the results of the tests the overall conclusion is that the exposure of product consists of very small particles, diameter < 30 nm.

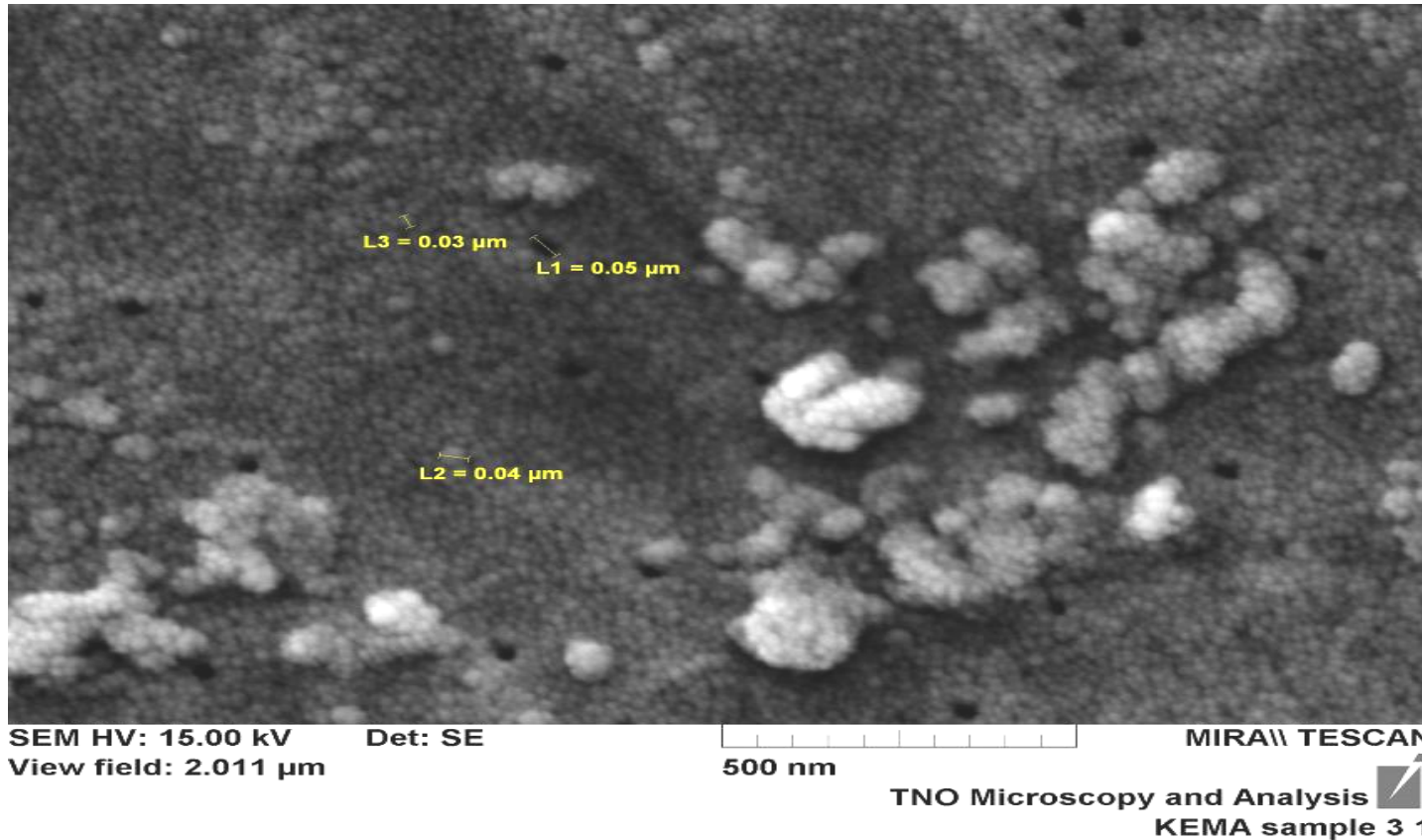
Enough information for Risk Assessment and control

Especially attention on the specific toxicity of the product.

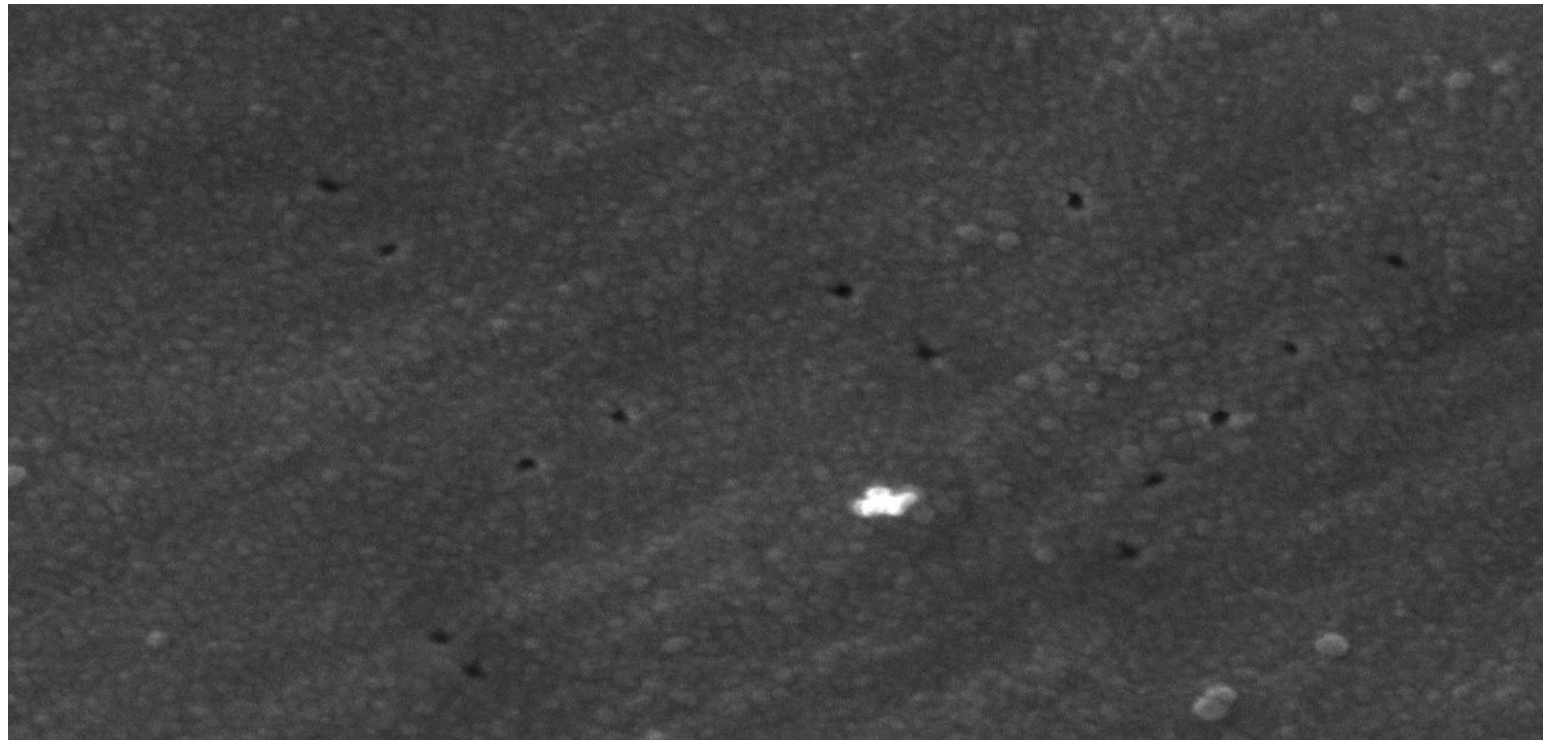
LAB test



Gold filter 20 nm poriensize (50.000 x)



Chrome filter 20 nm poriensize (100.000 x)



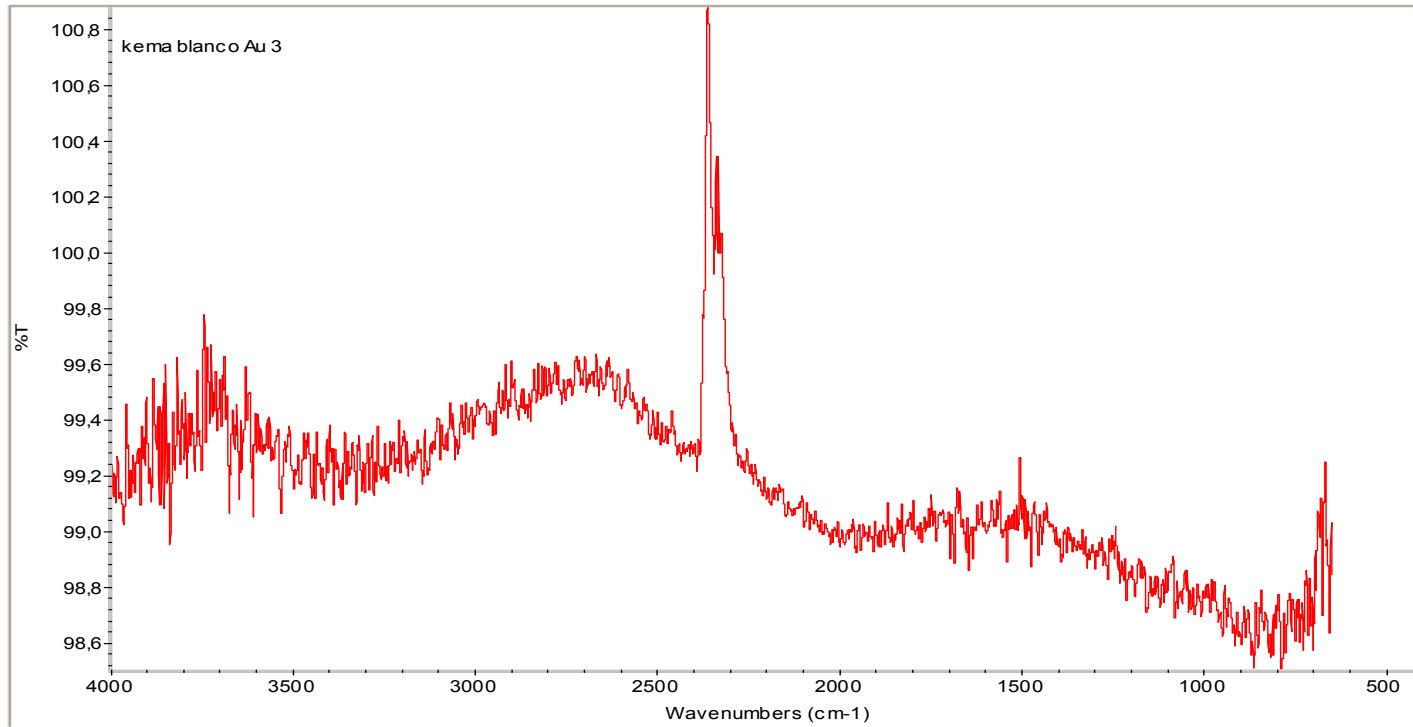
SEM HV: 15.00 kV Det: SE
View field: 2.011 μm

500 nm

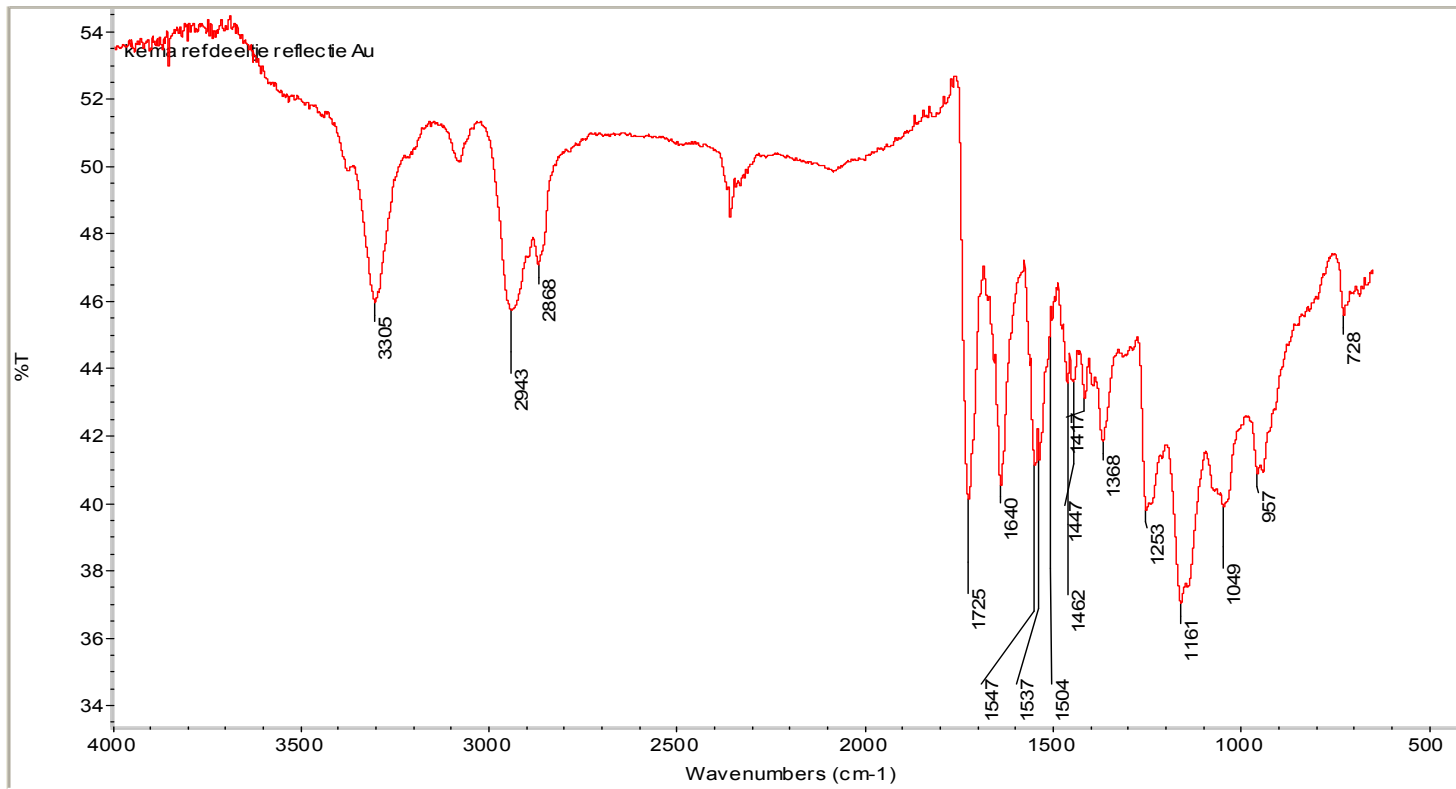
MIRAX TESCAN

TNO Microscopy and Analysis
Filter 2, Cr-coating, 100.000x

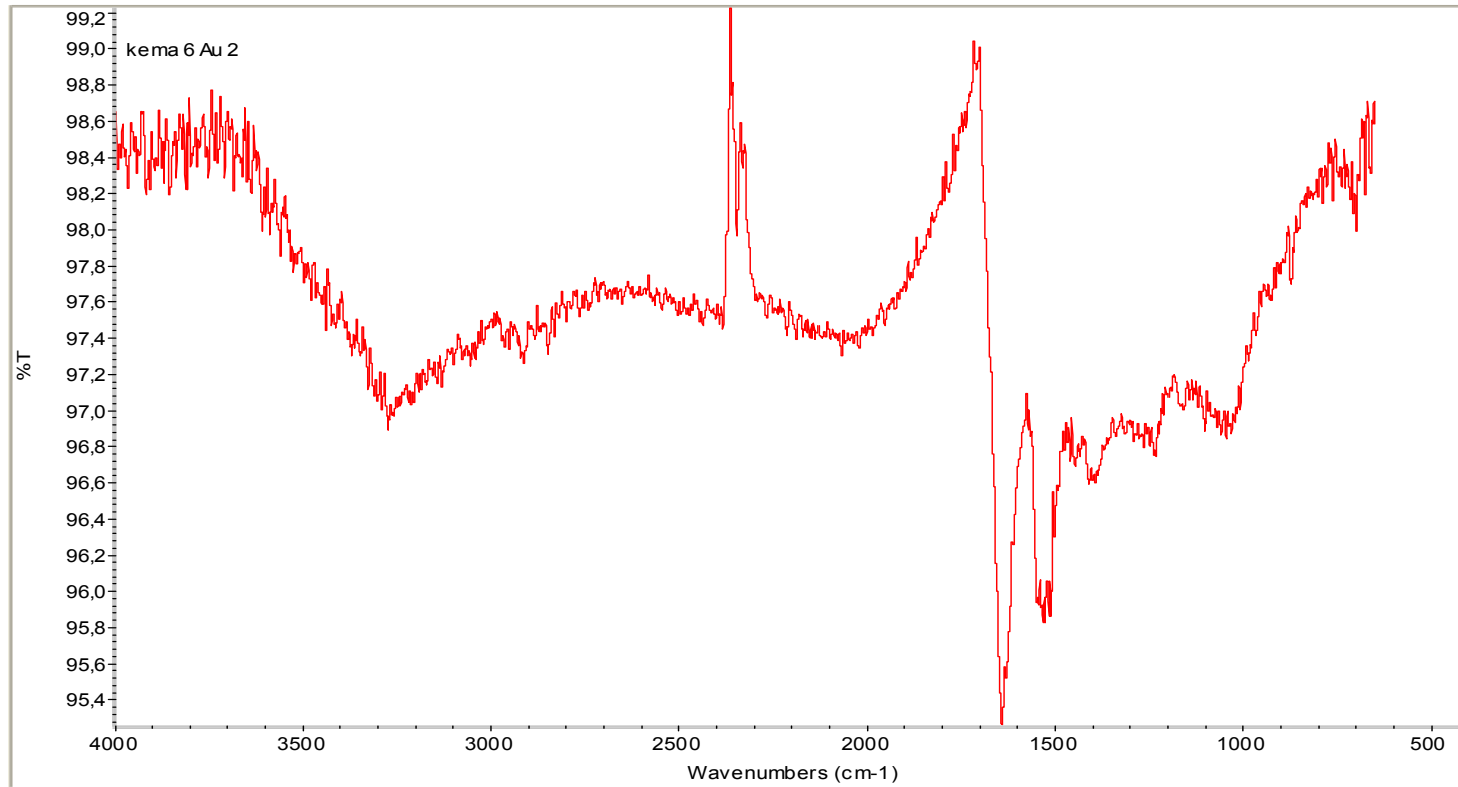
Infrared blanco filter



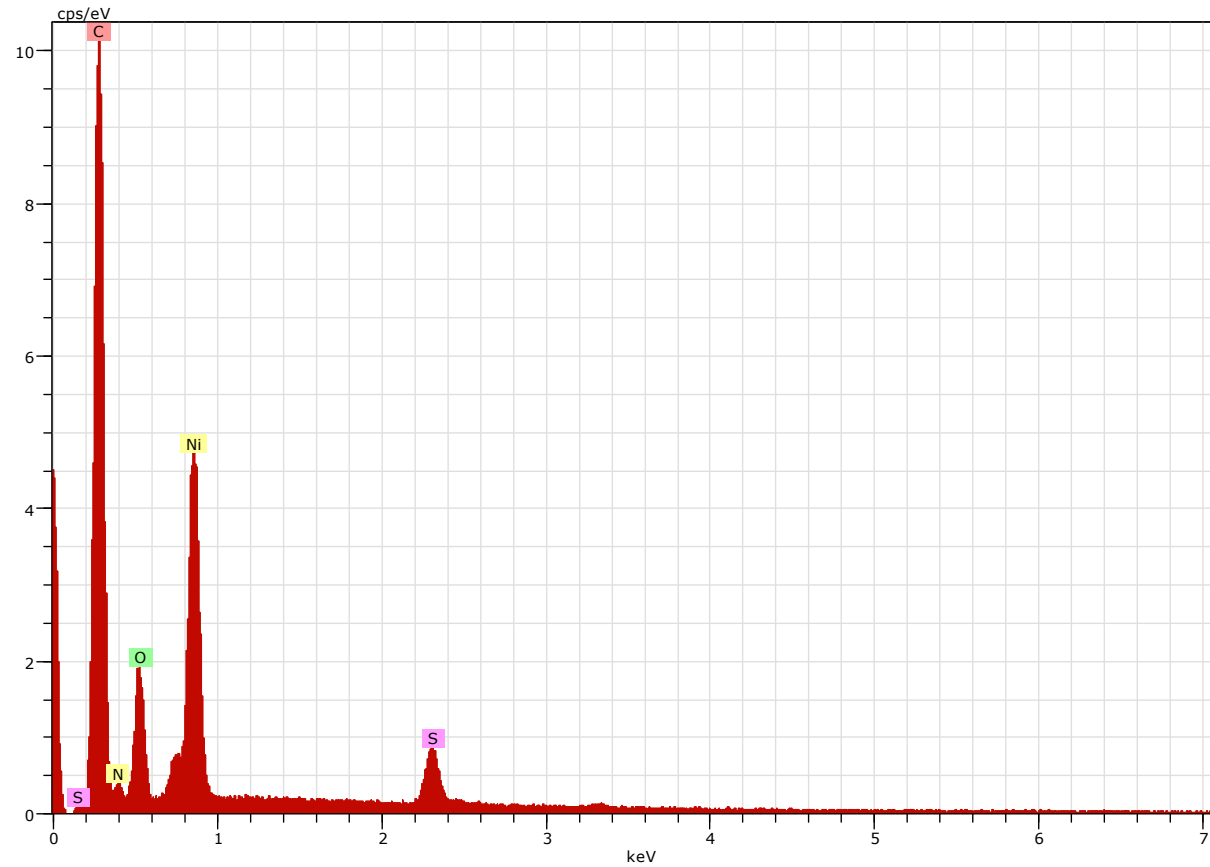
Infrared Spectrum Product



Infrared Spectrum particle (about 10 – 20 nm)



Röntgenspectrum



Thanks for Your Attention !!!

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