Elvatech
Advanced XRF equipment and solutions

Compliance with RoHS, WEEE, ELV on the spectrometers ElvaX, ProSpector

Introduction

Many international directives regulate the amount of hazardous elements in consumer products in order to reduce their harmful effects on human health and the environment. The best method for measuring the amount of heavy metals and other hazardous substances is X-ray fluorescence analysis. XRF analysis has high sensitivity to heavy metals (lead, mercury, chromium, antimony, etc. can be detected at a level of 1 ppm), great productivity and also allows to conduct a non-destructive analysis.

ElvaX and ProSpector are used for testing consumer products according to various directives, including ROHS, WEEE, ELV according to ASTM F2617-15 method.

Application

ElvaX and ProSpector solves a wide range of tasks, including analysis of conformity with the following directives:

- **EU RoHS II**. Restricted substances: Pb, Hg, Cd, Cr, PBB, PBDE in electronic devices.
- **EU WEEE**. Те же ограничения, что и в RoHS, но в отработанной электронике;
- **EU ELV**. Restricts the amount of some heavy metals (Cd, Pb, Hg, Cr (hexavalent)) in end-of-life vehicles;
- **USA CPSIA 2008**. Restricts the amount of lead in children's products at the level of 100 ppm.
- **USA Halogen free Directive**;
- **California Proposition 65**;

Methodologies:

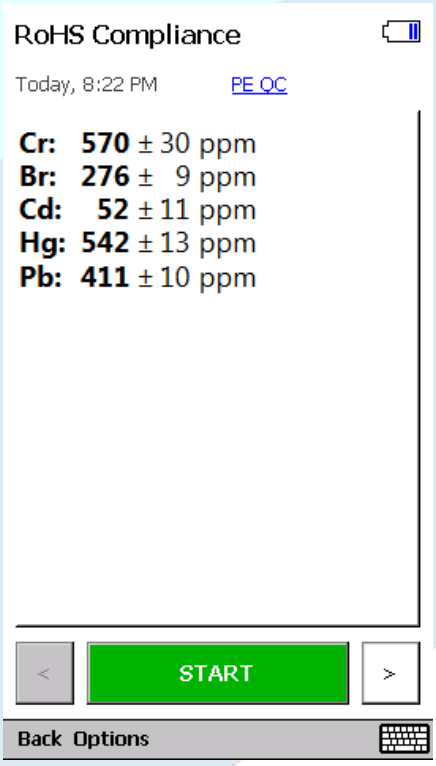
- **ASTM F2617-15**. Standard test method for quantification of Cr, Br, Cd, Hg, Pb in polymeric materials using XRF method.
- **ASTM F963-11**. Standard consumer safety specification for toy safety.
- **CPSC-CH-E1001-08.3**. Standard operating procedure for determining total lead (Pb) in children's metal products.
- **CPSC-CH-E1002-08.3**. Standard operating procedure for determining total lead (Pb) in non-metal children's products.

Equipment

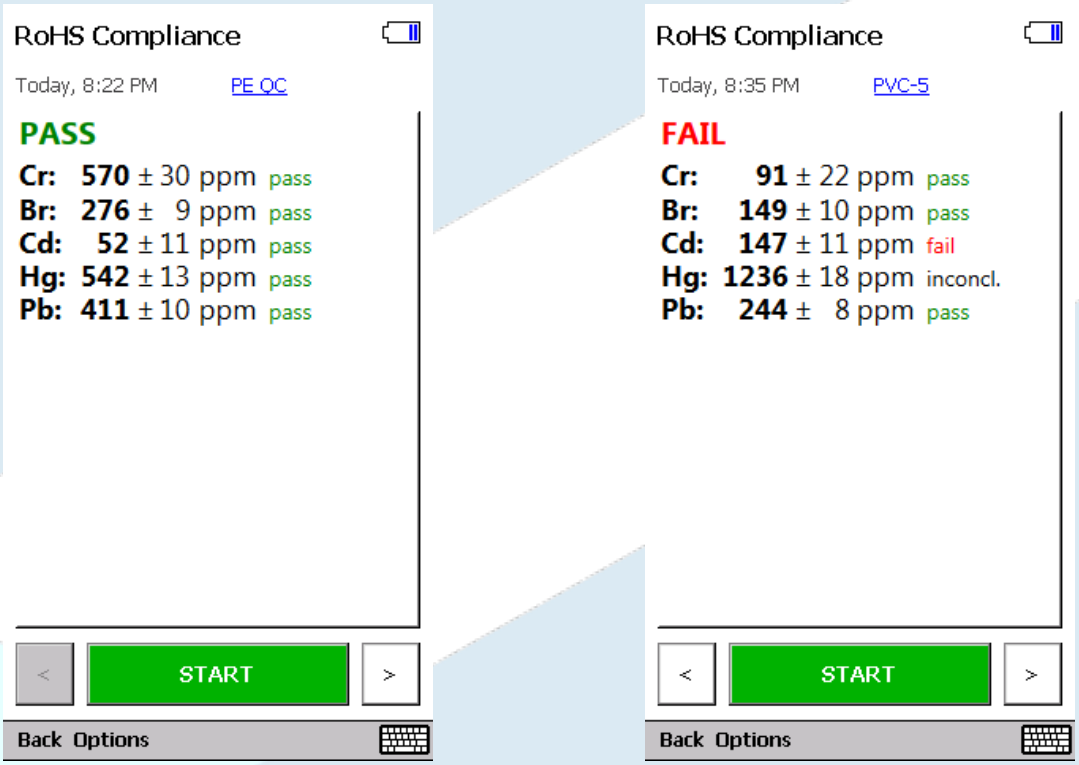
ProSpector is a handheld XRF spectrometers equipped with a 40 kW X-ray tube with tungsten anode, primary beam filter changer and SDD (or Si-PIN) detector. This device allows you to analyze all the toxic elements regulated by the above-mentioned directives.

The spectrometer weighs only about 1.5 kg, is simple to use and works for more than 10 hours on one battery charge.

The instrument presents analysis data in two ways: displaying of the whole sample composition (pic.1) and “Pass/Fail” mode (pic.2) indicating whether a chemical composition is compliant with the RoHS directive.



Picture 1. Results of measurement in the “Composition” mode



Picture 2. Results of measurement in "Pass/Fail" mode.

Methodology

ProSpector is calibrated to measure hazardous elements with a set of 16 standard samples of polyvinyl chloride and polyethylene.

Plastics can be analyzed directly without any sample preparation. In some cases, if a sample is non- homogeneous, it is recommended to make several measurements in different spots and average the results.

In the ROHS mode a two-pass X-ray mode is used. Anode voltage of 40kW and Ni 100 um filter are used in the first pass, and Ni300 um + Al 300 um filter - in the second.

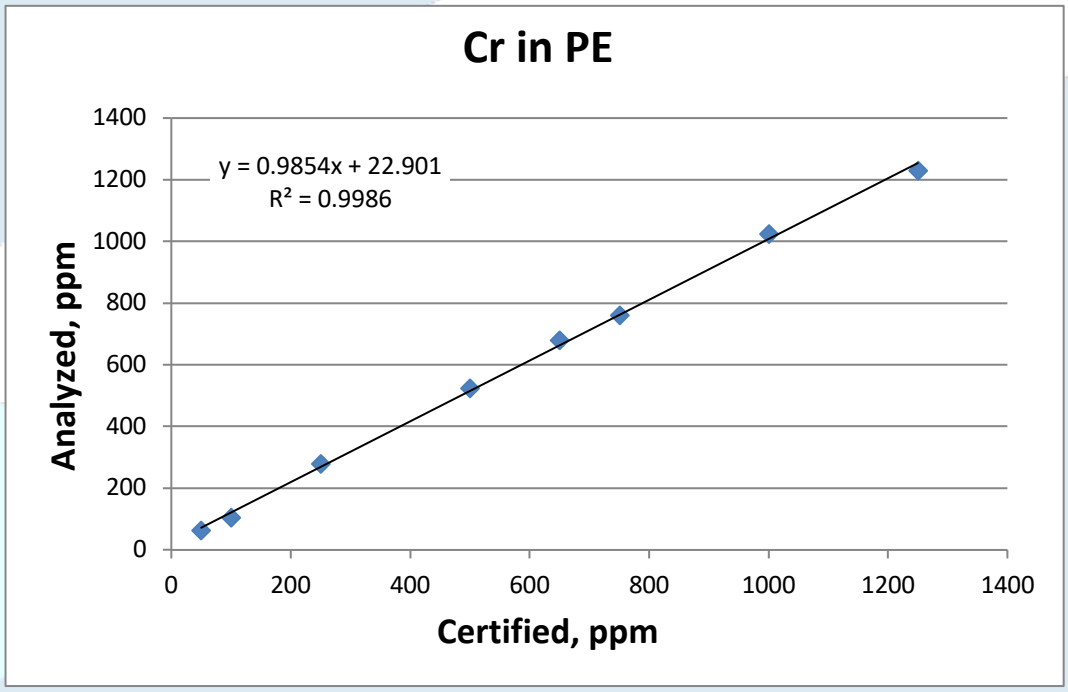
The average measurement time is 15 seconds with the SDD detector and 30 seconds with the Si-PIN detector. Increasing measurement time yields more accurate results.

Results

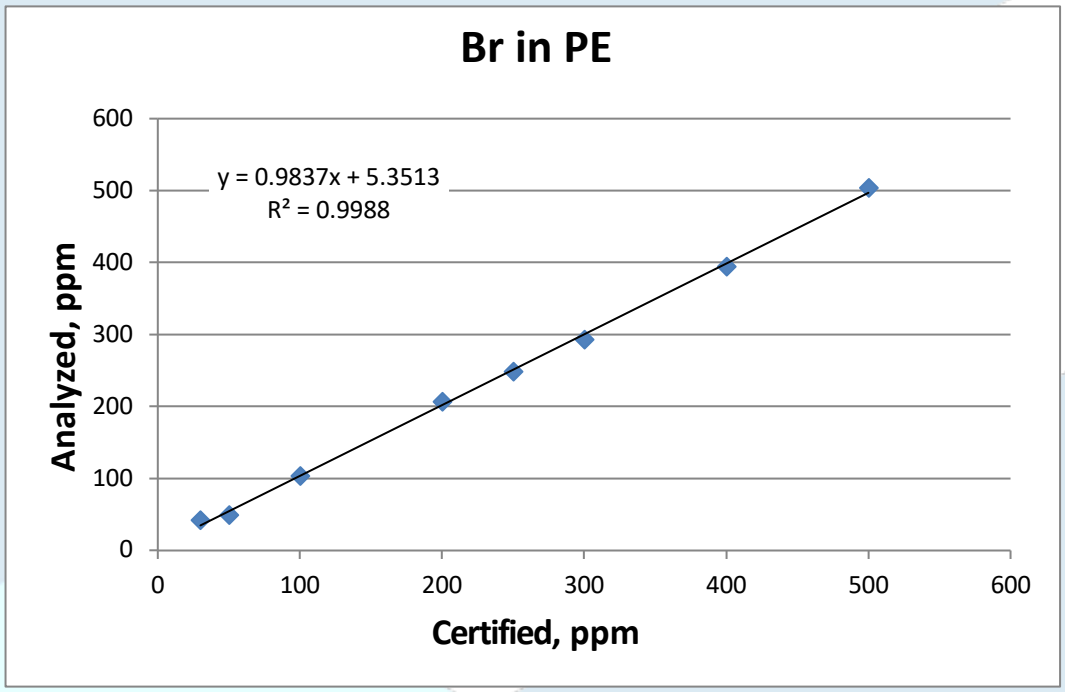
Pictures 3-12 show comparative graphs between certified and measured concentrations of chromium, bromine, lead, cadmium and mercury in polyethylene (PE) and polyvinyl chloride (PVC).

Received data is approximated by linear function.

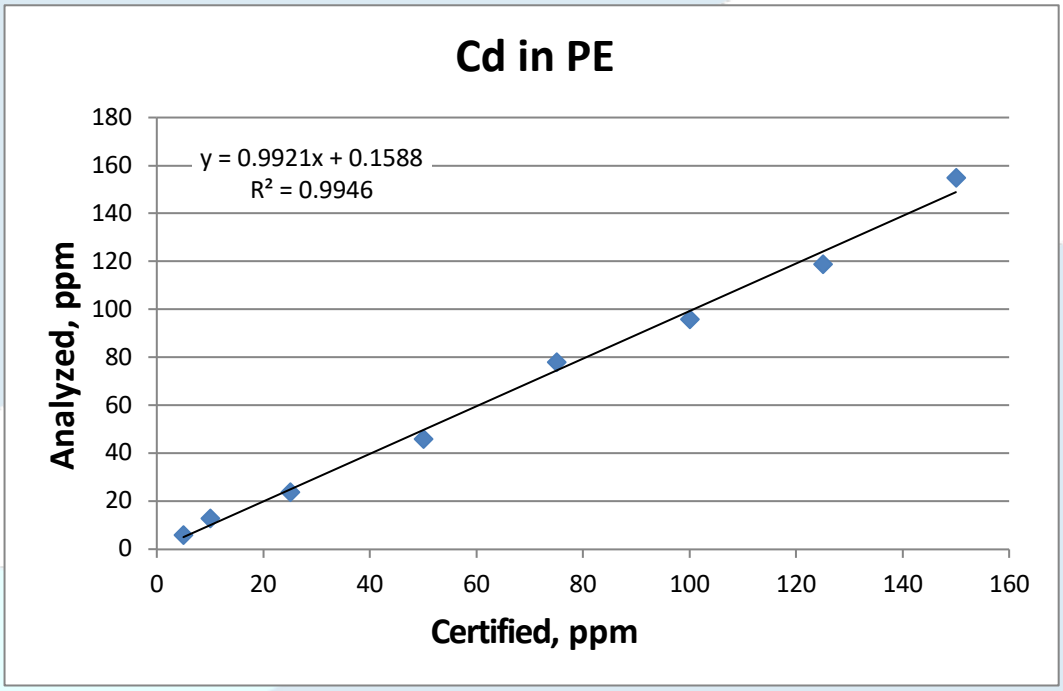
R^2 is the coefficient of approximation reliability, which shows how accurately the measurement results match the certified results. The ideal match is possible if the value of R^2 is equal to 1.



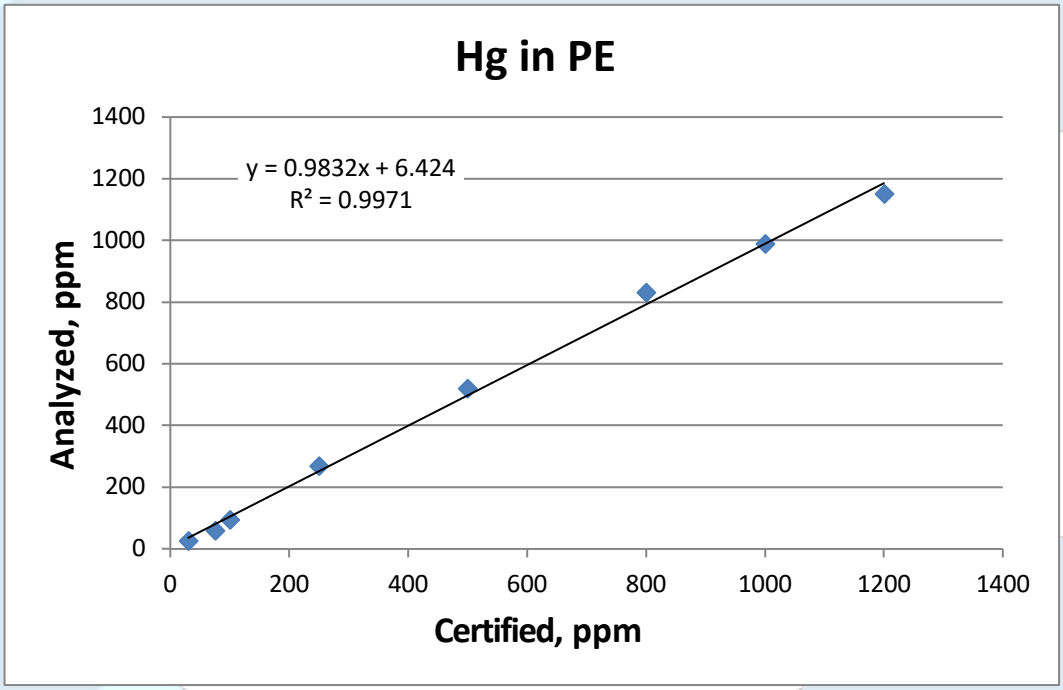
Picture 3. Graph of conformity of chromium concentration in polyethylene.



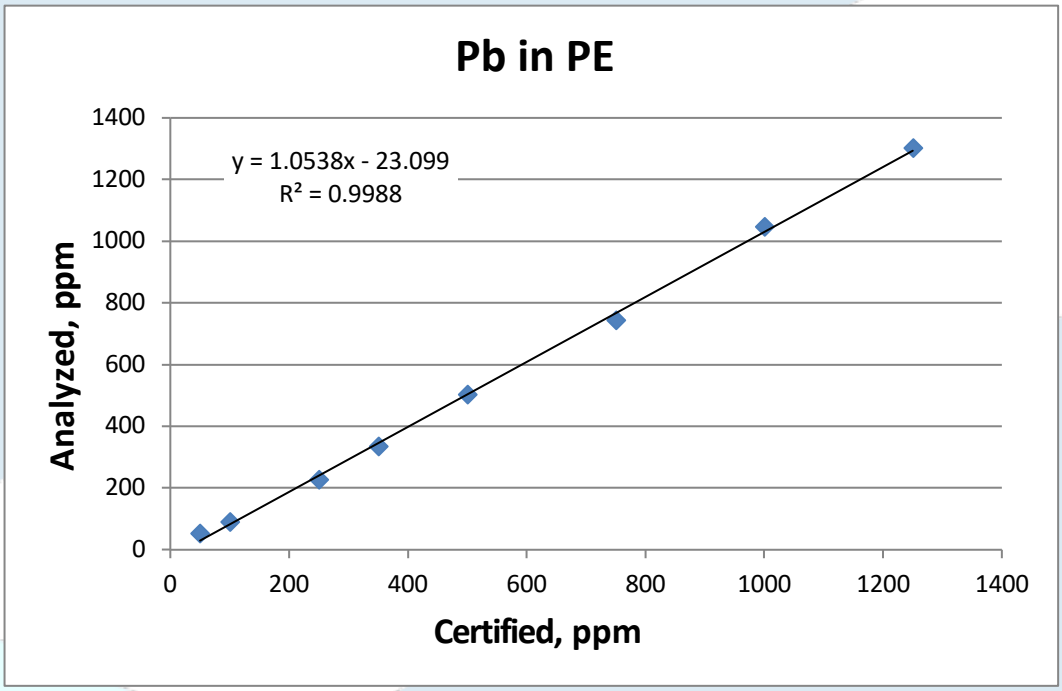
Picture 4. Graph of conformity of bromine concentration in polyethylene.



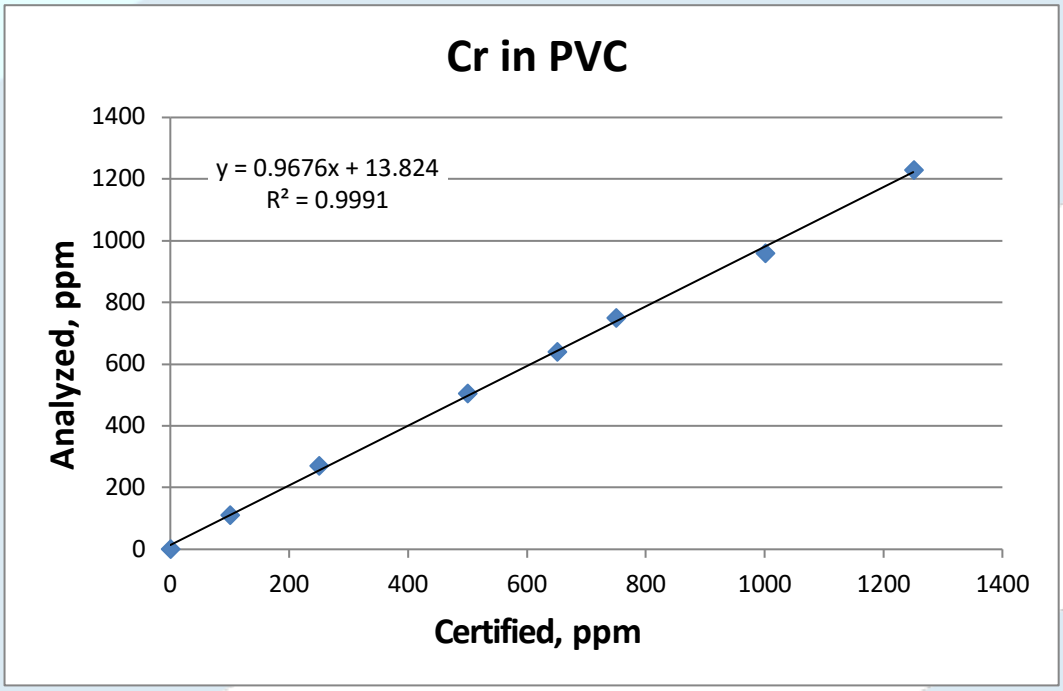
Picture 5. Graph of conformity of cadmium concentration in polyethylene.



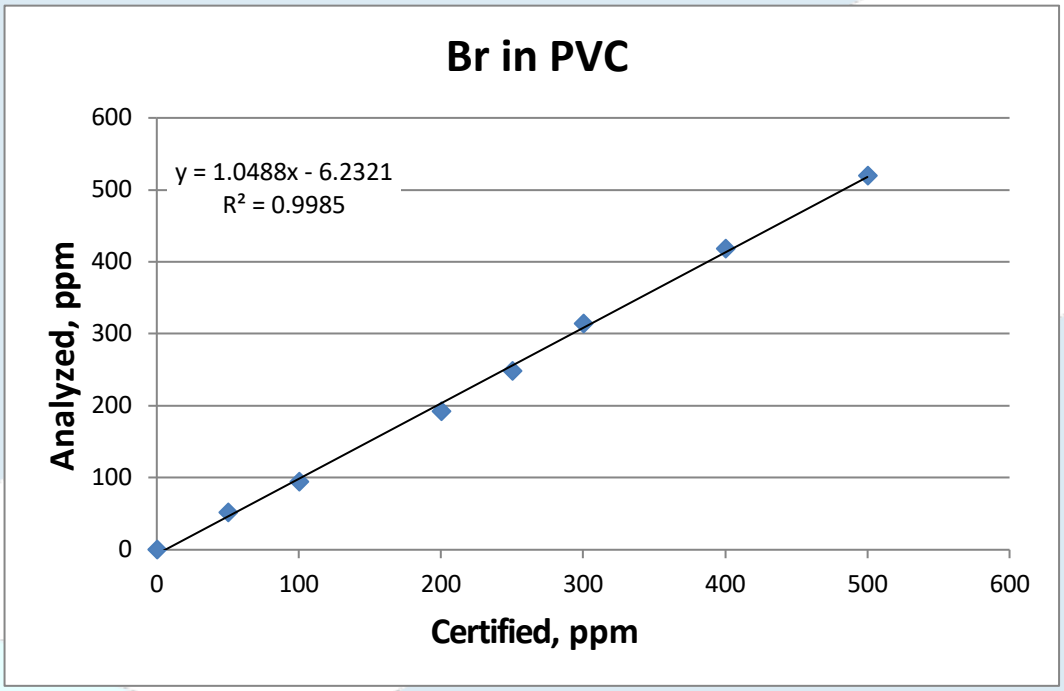
Picture 6. Graph of conformity of mercury concentration in polyethylene.



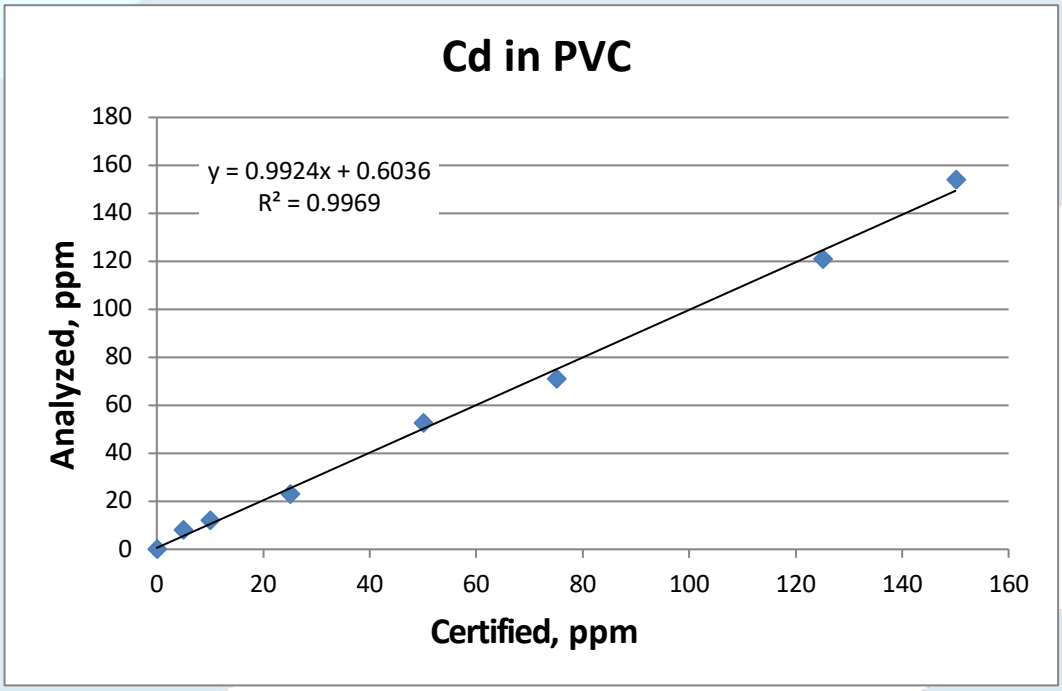
Picture 7. Graph of conformity of lead concentration in polyethylene.



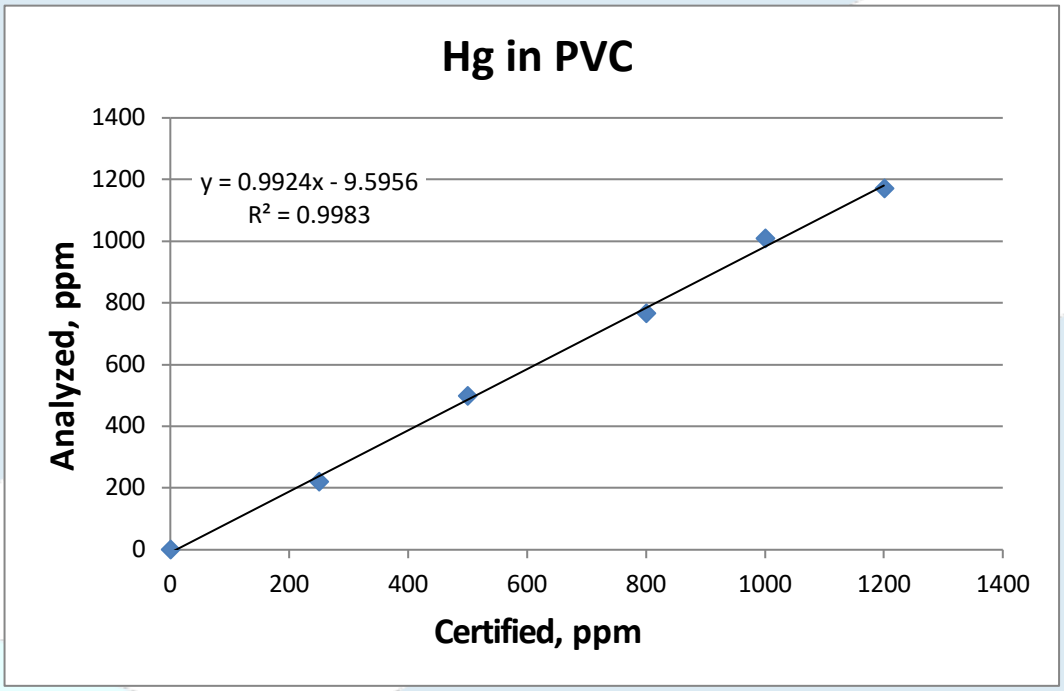
Picture 8. Graph of conformity of chromium concentration in polyvinyl chloride.



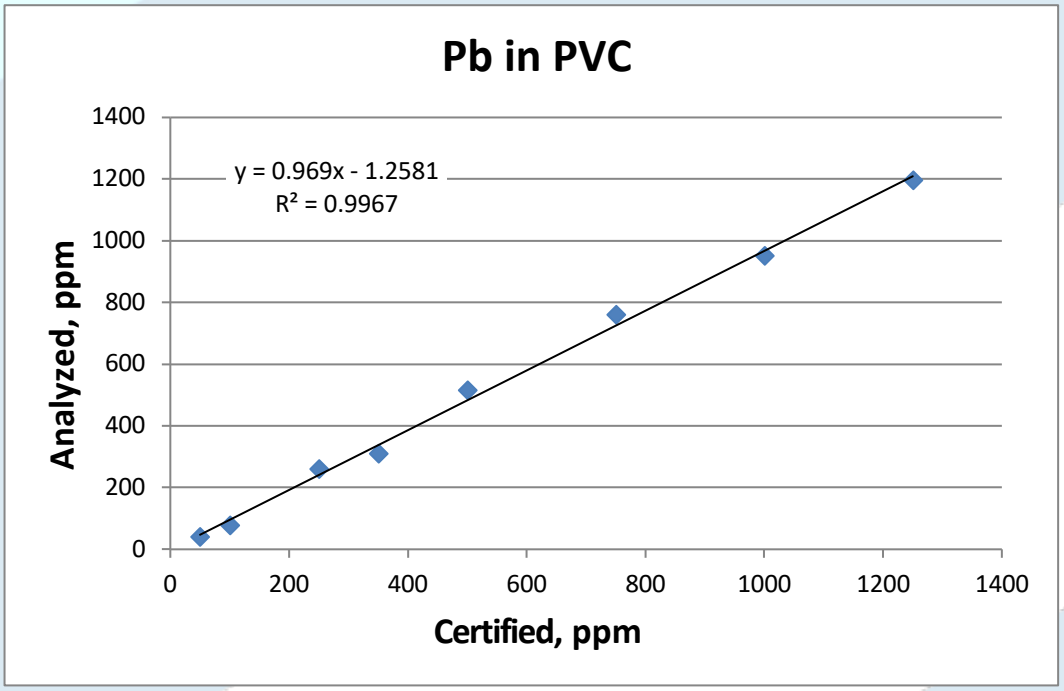
Picture 9. Graph of conformity of bromine concentration in polyvinyl chloride.



Picture 10. Graph of conformity of chromium cadmium in polyvinyl chloride.



Picture 11. Graph of conformity of mercury concentration in polyvinyl chloride.



Picture 12. Graph of conformity of lead concentration in polyvinyl chloride.

Also, a repeatability test was conducted. Standard samples of polyethylene and polyvinyl chloride were measured 10 times, each 30 seconds. Average concentration, standard deviation (SD) and relative standard deviation (RSD - in percent) were calculated.

Test results for polyethylene are given in table 1 and for polyvinyl chloride — in table 2.

PE	Concentration, ppm				
Measurement #	**Cr**	**Br**	**Cd**	**Hg**	**Pb**
1	528	237	48	480	469
2	502	224	45	475	457
3	502	230	50	472	459
4	489	233	51	465	460
5	516	234	51	473	464
6	510	232	48	471	461
7	513	233	45	477	465
8	517	234	48	475	459
9	508	237	44	476	468
10	516	231	50	468	458
Average	**510.1**	**232.5**	**48**	**473.2**	**462**
SD	**7.9**	**2.6**	**2**	**3.4**	**3.6**
% RSD	**1.55**	**1.12**	**4.17**	**0.72**	**0.78**

Table 1. Repeatability test of polyethylene measurements.

PVC	Concentration, ppm				
Measurement #	**Cr**	**Br**	**Cd**	**Hg**	**Pb**
1	438	271	43	498	538
2	415	260	61	485	521
3	425	262	46	494	523
4	434	271	51	503	544
5	433	271	47	494	539
6	412	257	44	483	517
7	432	260	52	483	519
8	435	274	46	505	538
9	464	275	49	505	552
10	416	274	47	512	556
Average	**430.4**	**267.5**	**48.6**	**496.2**	**534.7**
SD	**10.72**	**6.2**	**3.72**	**8.4**	**11.76**
% RSD	**2.49**	**2.32**	**7.65**	**1.69**	**2.2**

Table 2. Repeatability test of polyvinyl chloride measurements.

Conclusion

Obtained results show good correlation between certified and measured concentrations of hazardous elements in plastics. Also, ProSpector is capable of analyzing harmful elements in metals and alloys.

The spectrometer is suitable for compliance against most European and U.S directives, including ROHS 2, WEEE, CPSIA etc.

The main advantages of the ProSpector handheld spectrometer are high accuracy and measurement time, non-destructive analysis and no need for sample preparation.