Positron annihilation spectroscopy in material research

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Theory

Source of the positrons - β^+ decay:

$$p \rightarrow \ n + e^+ + \nu_e \tag{1}$$

Doppler effect dependence on the momentum of annihilating pair:

$$E_\gamma \simeq mc^2 + E_B \pm \frac{p_\parallel c}{2} \tag{2}$$

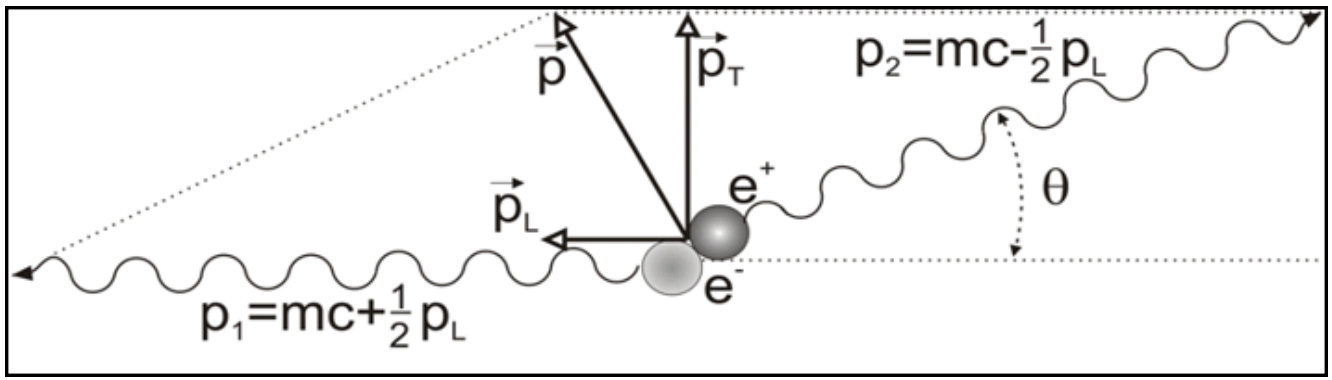


Figure: Two gamma quanta emission ($511keV$) from the pair e^+ and e^- with momentum p annihilation.

DB method description

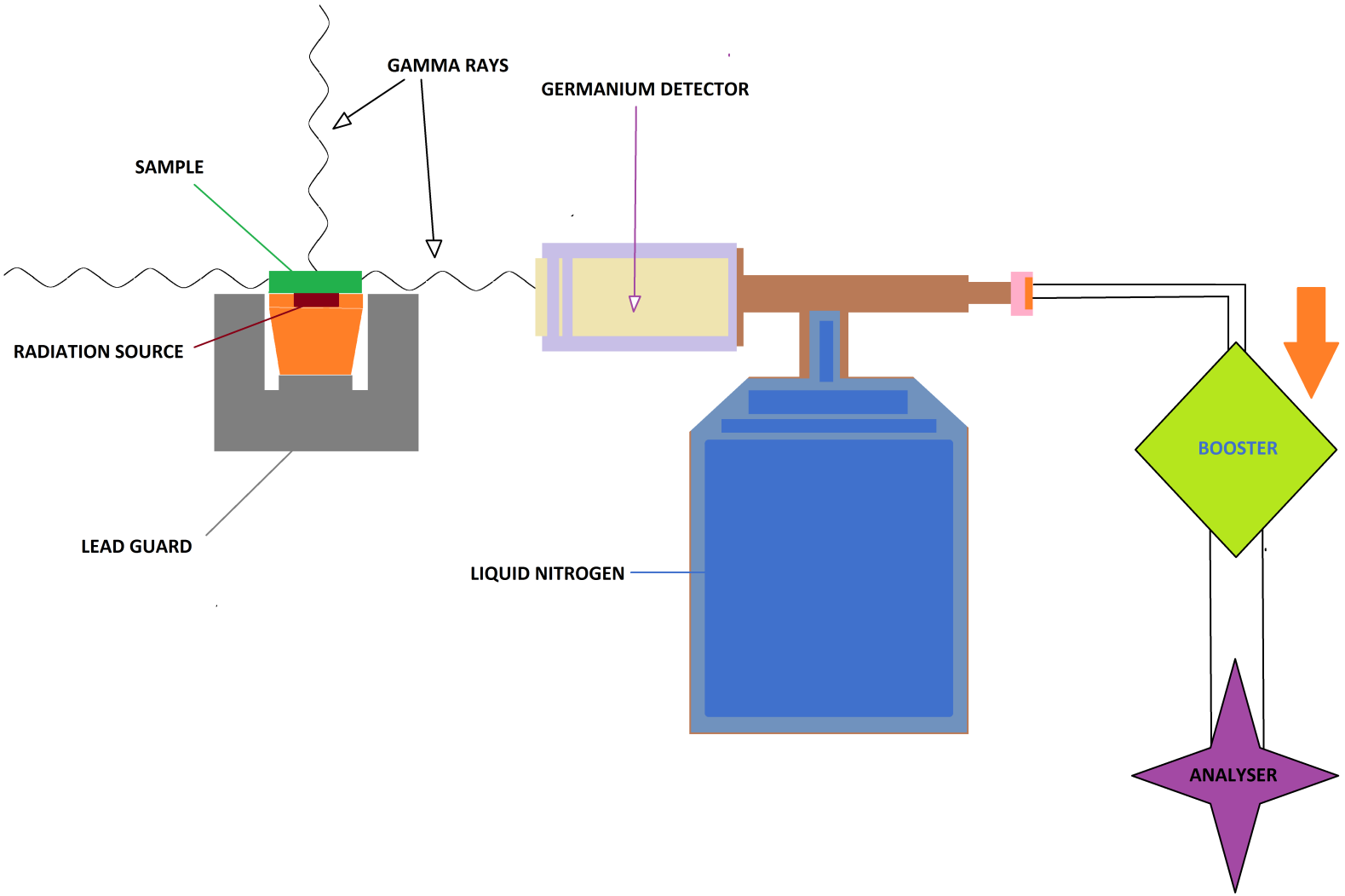


Figure: Scheme of the measuring system.

Spectrum of ^{22}Na

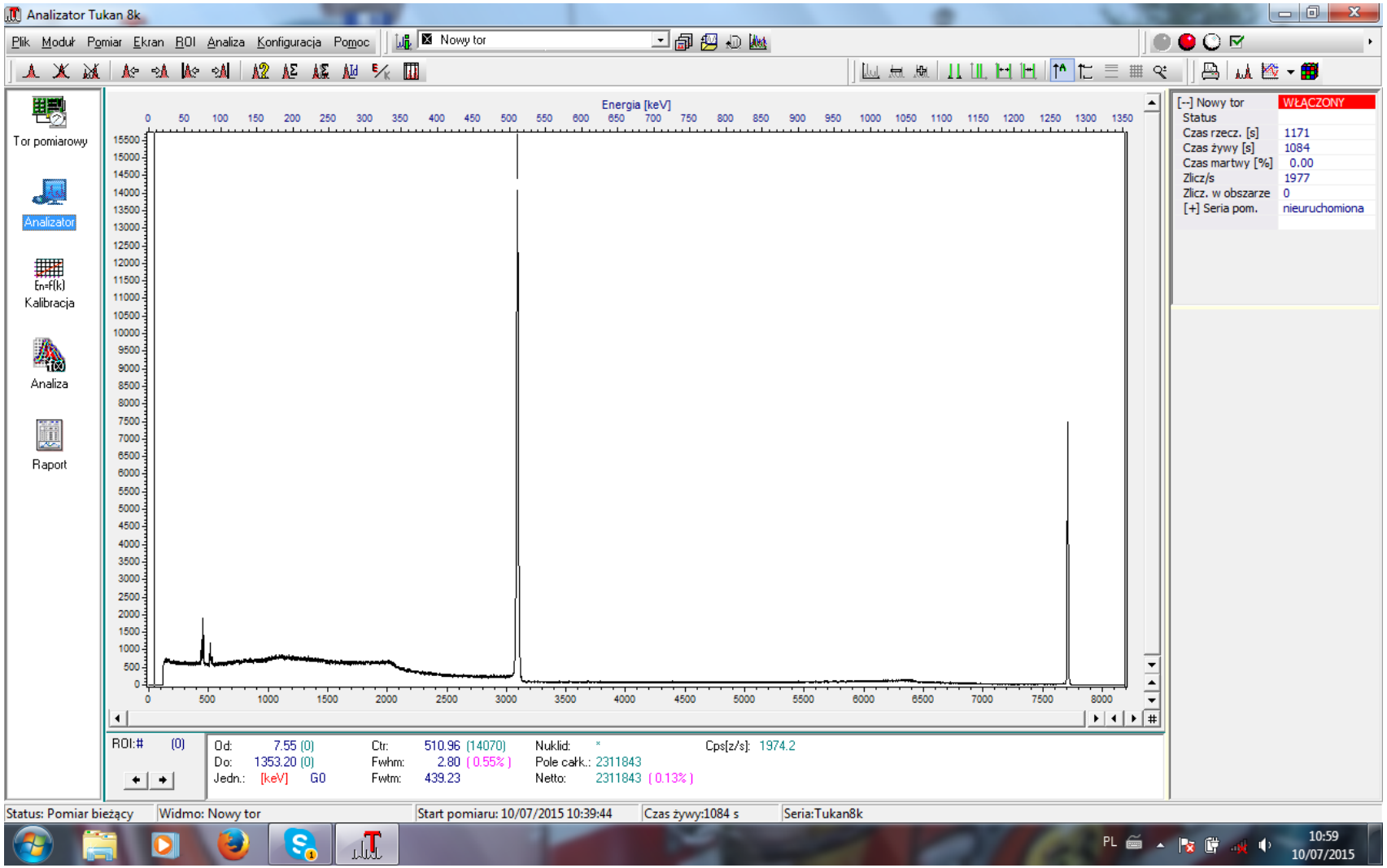


Figure: Spectrum of ^{22}Na

Annihilation line

$$S = \frac{A_s}{A}, \qquad W = \frac{A_w}{A}$$

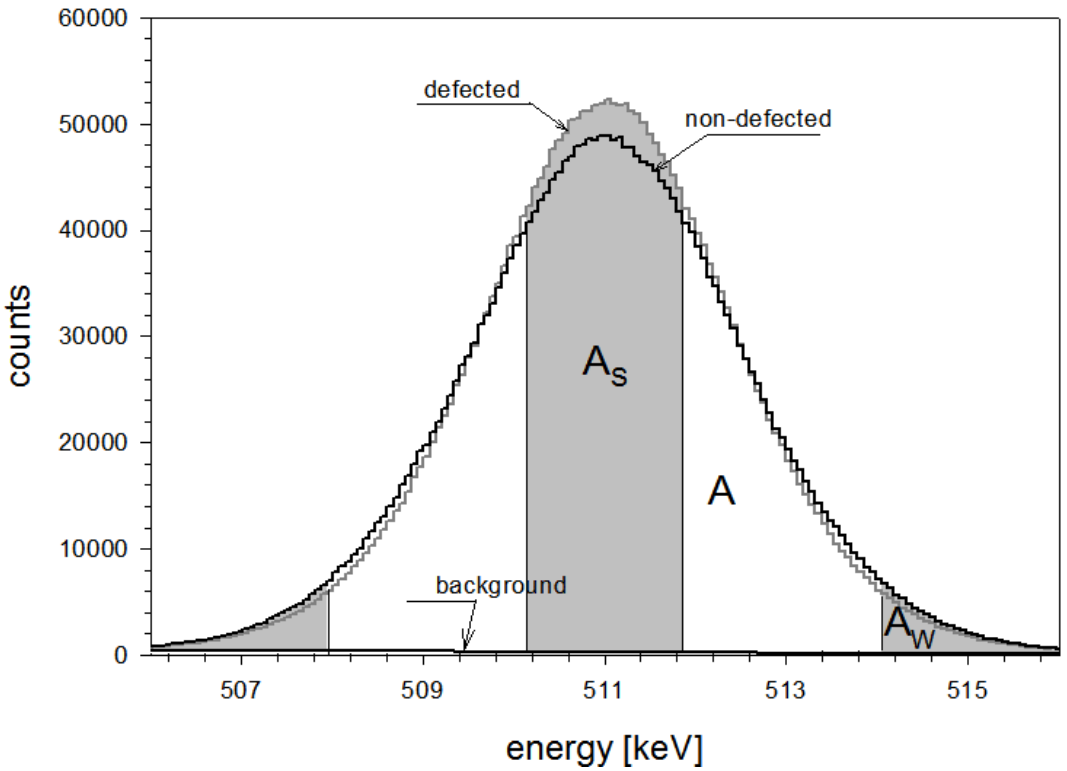
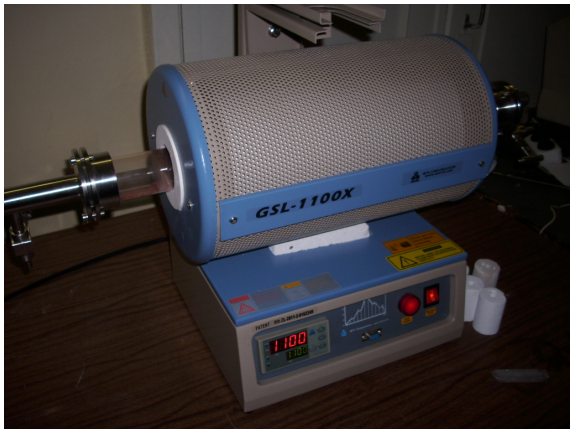


Figure: Annihilation line.

Sample preparation

(a) Ultrasonic cleaner



(b) Vacuum heater

(c) Cleaning with ethanol

(d) Ready samples

Results: Bronze sample - sandblasting

Figure 1a. S parameter in dependency on the etched depth .

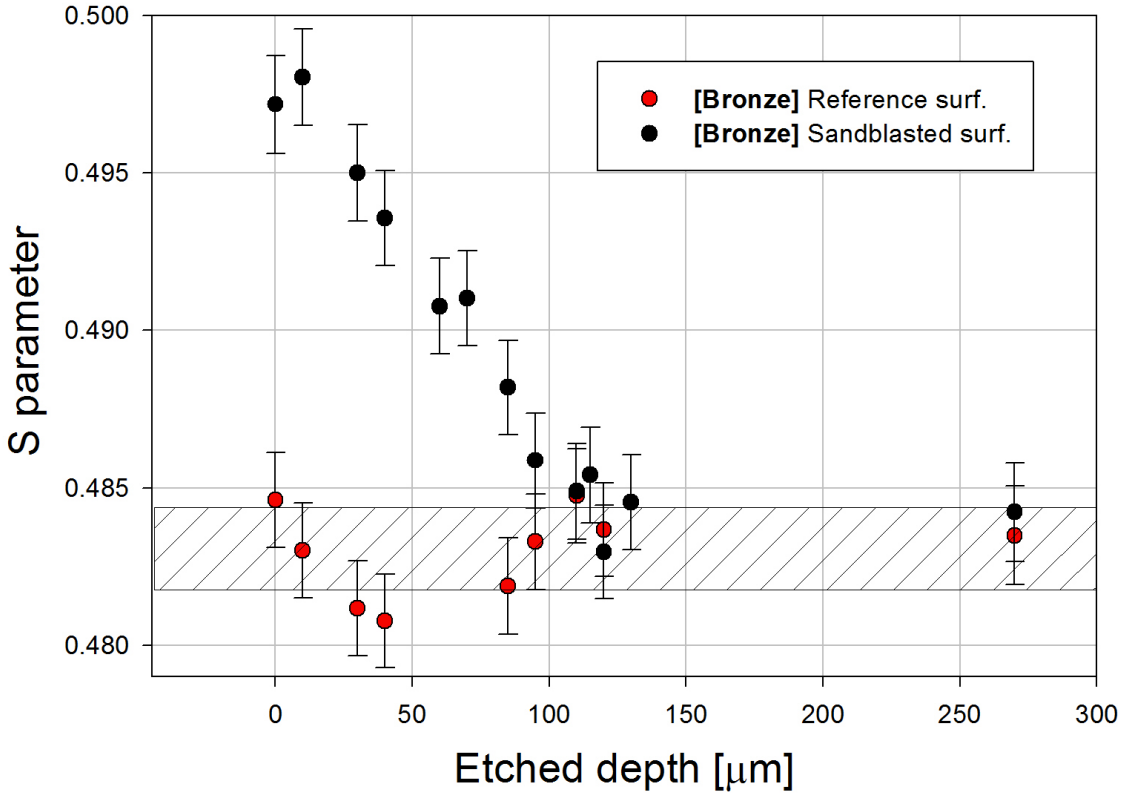
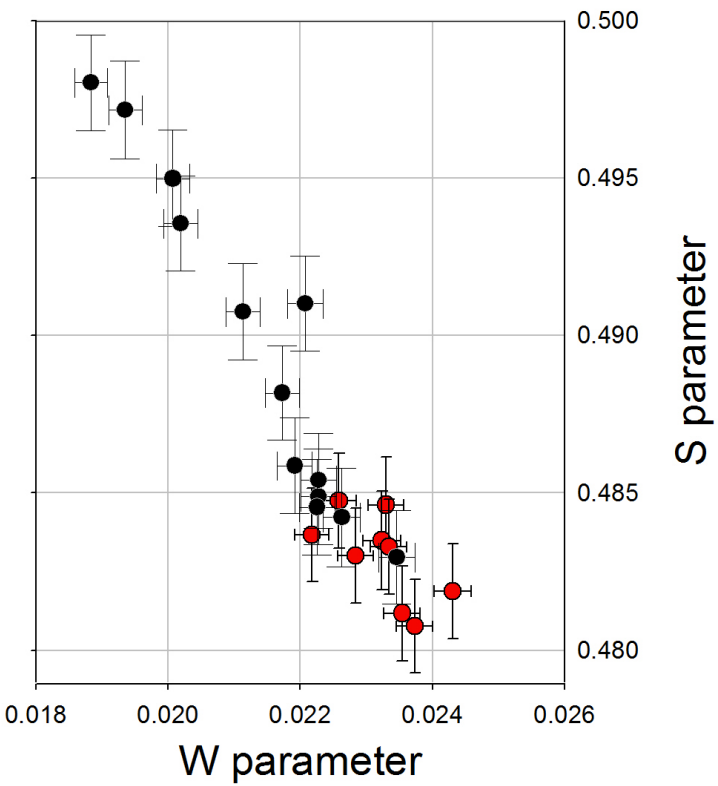


Figure 1b. S vs. W



Results: Copper sample - sandblasting

Figure 2a. S parameter in dependency on the etched depth.

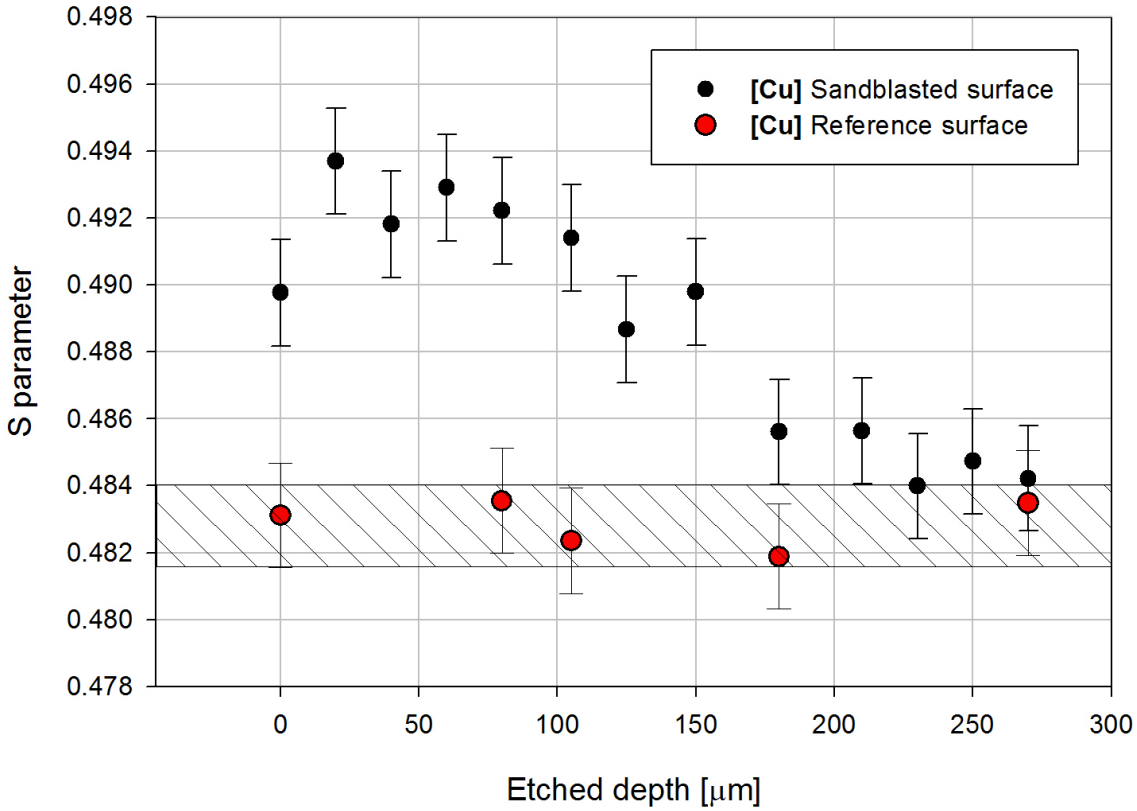
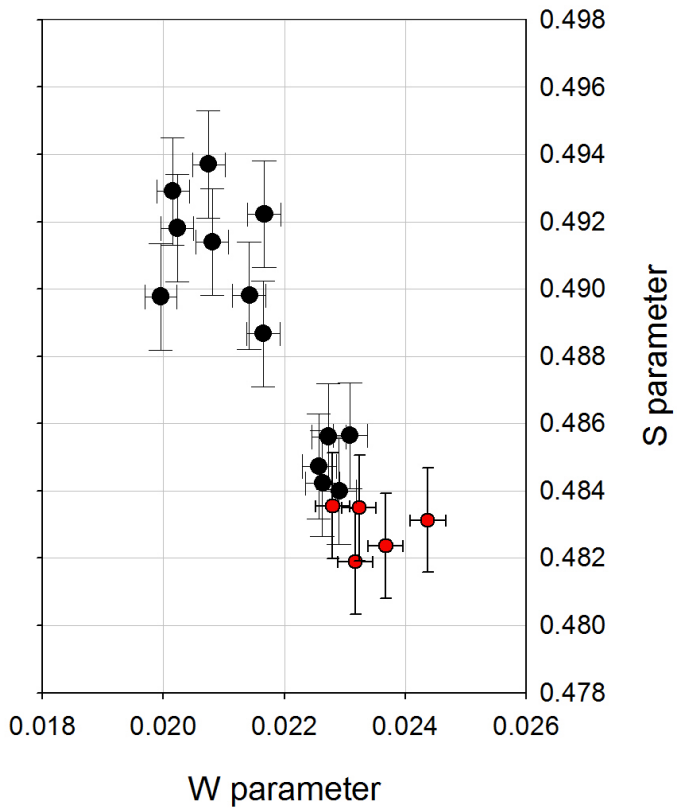


Figure 2b. S vs.W



Results: Copper sample - pressed

Figure 3a. S parameter in dependency on the etched depth.

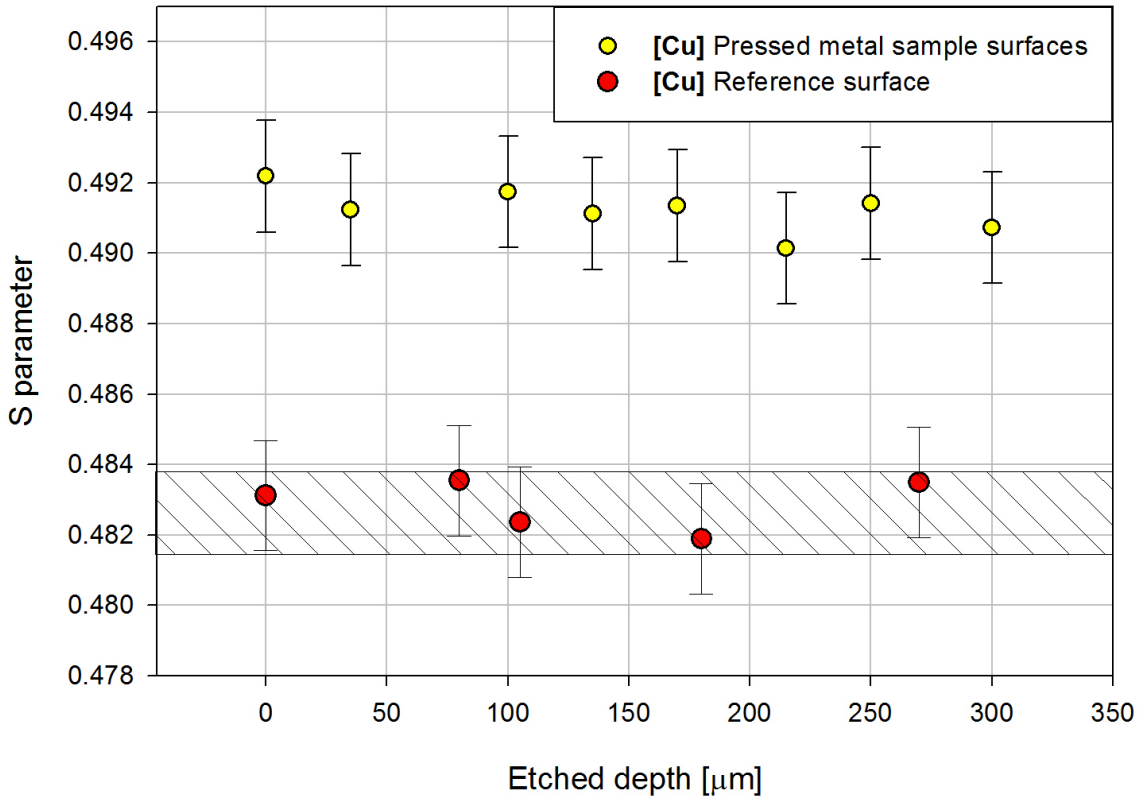
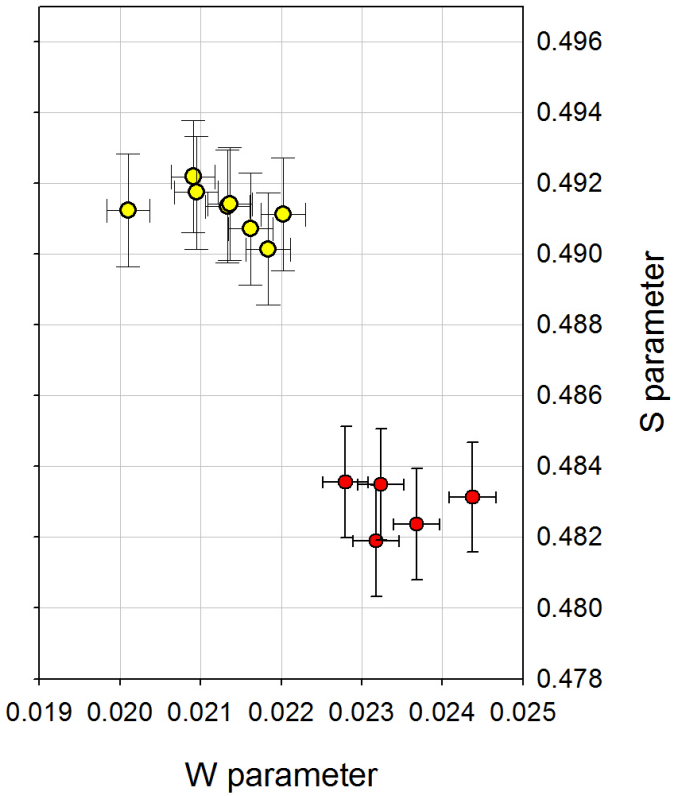


Figure 3b. S vs. W



Results: Copper sample - comparison

Figure 4a. S parameter in dependency on the etched depth.

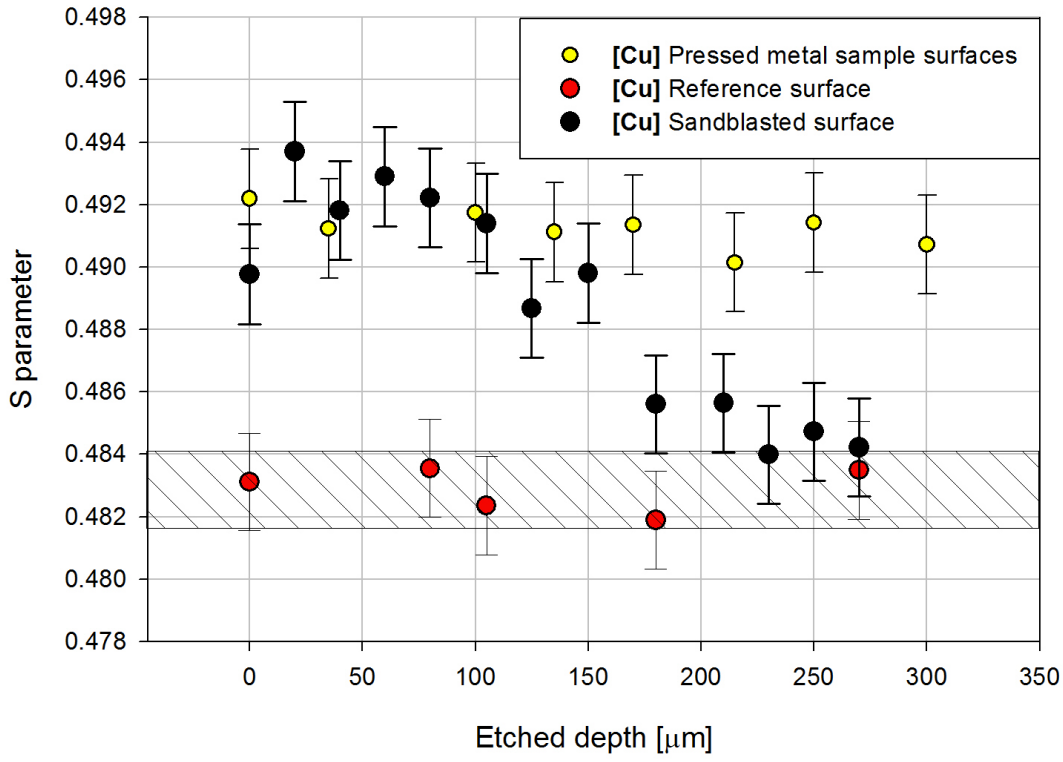
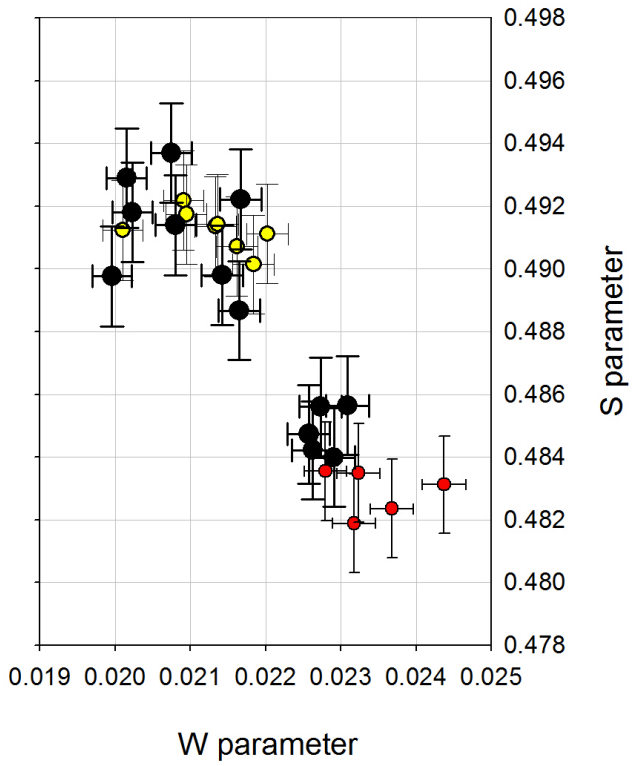


Figure 4b. S vs. W



Conclusions

- The measurements:
  we used DB spectroscopy to investigate three different samples: sandblasted copper, pressed copper and sandblasted bronze.
- The analysis:
  in case of the sandblasted samples the S parameter was decreasing simultaneously with the depth. And in case of the pressed sample it was oscillating around the specific value for all depths.
- The result:
  all the outcomes are consistent with the theoretical considerations.

Thank you for your attention!

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