# Alanine-EPR dosimetry system for high industrial as well radiotherapeutic dose measurement

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Alanine-EPR dosimetry system is primarily dedicated for application at high industrial dose measurements. Alanine-EPR dosimetry system has undergone in recent years development concerning an alanine – the radiation sensitive detection material as well as EPR spectroscopy evaluating system. This fact transformed the alanine-EPR dosimetry from expensive research laboratory tool to special affordable automated routine high dose dosimetry system. Its development still continues, particularly at some national metrology institutes. The goal of that effort is better understanding of particular effects in dosimetry chain, their suppression and consequently improvement of dose determination accuracy. The following practical application for radiotherapy, in situ dose measurements as well as a non-destructive in vivo dosimetry applicable directly to individuals can be foreseen [1].

## Range of alanine-EPR dosimetry

EPR (Electron Paramagnetic Resonance, also known as ESR - Electron Spin Resonance) has long been used as a quantitative tool to study the effects of radiation. Ionising radiation produces free radicals in many forms of matter that can be quantitatively detected by an EPR spectrometer. The spectrometer works by measuring energy level transitions of free unpaired electrons at a specific resonant frequency within a variable magnetic field.

Alanine-EPR dosimetry is based on the generation of specific stable radicals in polycrystalline alanine powder when subjected to ionising radiation. The dosimeter is made of α-alanine and registers the absorbed dose by an increase in the alanine/derived radical concentration. Identification and determination of the concentration of the specific alanine radical are performed by EPR spectroscopy. Alanine dosimeters are used usually as pellets, films or powder depending on the application

The alanine free radical yields an EPR signal that is dose dependent, is independent of the dose rate, quality of radiation, and is relatively insensitive to temperature and humidity. Alanine dosimetry is equally suited to gamma, electron beam, or X-ray radiation measurement, especially for irradiation facilities. Measurement of the concentration of free radicals by EPR spectroscopy is non-destructive. Alanine dosimeters can be read out repeatedly and hence can be used for archival purposes.

The standard utilisation of alanine-EPR dosimetry for absorbed dose measurements is under following conditions: the absorbed dose range between 1 Gy and $2 \cdot 10^5$ Gy; the absorbed dose rate up to $10^2$ $Gy \cdot s^{-1}$ for continuous radiation fields and up to $5 \cdot 10^7$ $Gy \cdot s^{-1}$ for pulsed radiation fields; the radiation energy for photons and electrons is between 0.1 MeV and 28 MeV; the efficiency of neutron radiation measurement is about 60 %; the applicable irradiation temperature is between -60 to +90 °C.

## Development of alanine-EPR reference dosimetry standard

Slovak Institute of Metrology is developing new metrology standard for high doses, based on the alanine-EPR as a reference dosimetry system. A Bruker e-scan EPR analyser developed specifically for alanine dosimetry has improved stability of EPR measurement, especially at lower dose range. The standard e-scan system provides sensitivity below 1 Gray. After further improvement of the system and lowering of dose determination expanded uncertainty down below 1 %, its utilisation for radiotherapy field is expected

## References:

[1] D.F. Regula, ESR spectrometry:a future –oriented tool for dosimetry and dating, Applied Radiation and Isotopes 62 (2005) 117-127