Radiation-Induced Free Radicals in UHMWPE: A comprehensive study for a period of 25 Years

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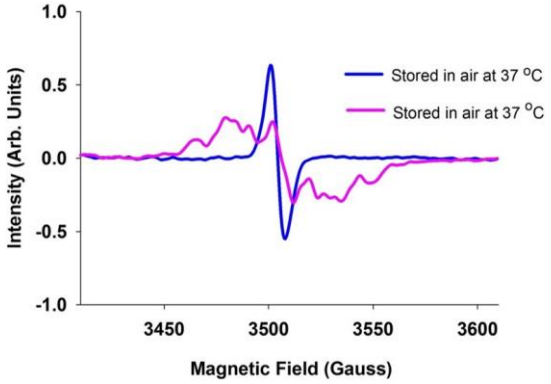
Summary:

The Electron Spin Resonance (ESR) technique has been used to evaluate free radicals in gamma-irradiated (30kGy) UHMWPE for, now, up to 25 years, which is closer to a full lifetime of an implant than has been previously evaluated. Effects of temperature, oxygen exposure (air vs. sealed/inert), as well as the antioxidant (vitamin E blended in and bovine solution diffused in), were checked. Open-air and inert-sealed samples both showed a detectable quantity of radicals except the samples aged at 75°C in open-air, even after 25 years of storage. Samples in inert environments showed a presence of remaining primary radicals (which had been initially produced by gamma radiation), which decreased with temperature, but not totally, and the addition of antioxidants (vitamin E and bovine solution) into UHMWPE samples indicated oxidation protection.

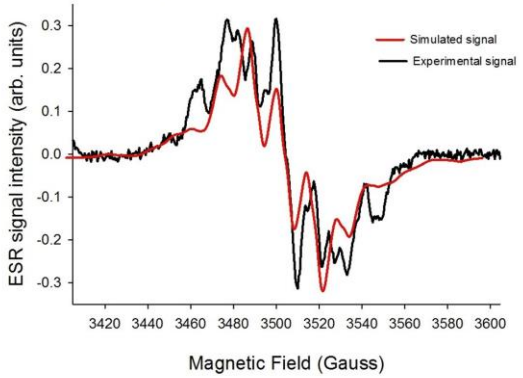
Materials and Testing

ESR Testing Results:

ESR Spectra of air and inert storage UHMWPE sample, after 25 years of aging at body temperature (37°C)



Presence of primary (initially-produced) radicals in 30 kGy gamma-irradiated UHMWPE, after 25 years of aging in vacuum sealed tube at body temperature (37° C)



Alkyl	8
Allyl	46
Polyenyl	17
Dienyle	23
Trienyle	6
Vitamin E	0
Total	100