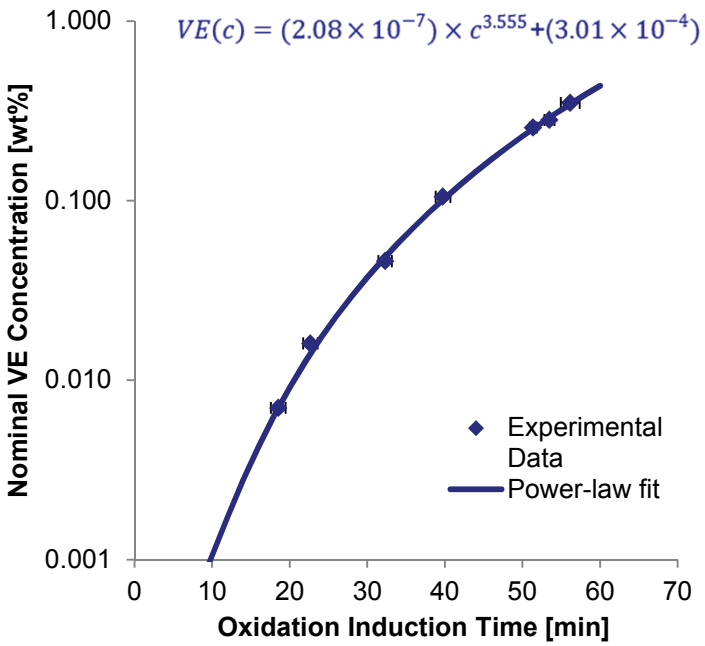
OIT as a measure of active antioxidants

Summary

The third generation ultra-high molecular weight poly(ethylene) (UHMWPE) materials currently being used in orthopaedics, rely on antioxidants to stabilize their properties over time. Until now, no reliable method for measuring trace amounts has been available. Cambridge Polymer Group is the first group to utilize thermal stability as an indicator for effective antioxidant concentration, even after processing. Although originally developed to examine the concentration of Vitamin E, this technique will find value in determining the effective concentration of any antioxidant present in the material.



Description

One of the challenges in manufacturing oxidatively stabilized polyethylene is determining the amount of active antioxidant in the formulation. After compounding and processing, this may be significantly lower than desired and it is therefore vital for quality control purposes to determine these levels before implantation. In addition, the potentially low concentrations involved mean that conventional techniques are inadequate. CPG realized that a standard ASTM technique (D3895) could be leveraged to provide a simple power-law relationship between Vitamin E concentration and OIT value using a standard DSC. The small sample size, rapid turnaround and ease of sample preparation make this technique a natural for quality control purposes.

Data and outcomes

	Unirradiated Powder		Unirradiated Consolidated		Irradiated Consolidated	
Vitamin E [wt%]	OIT [min]	St. Dev. [min]	OIT [min]	St. Dev. [min]	OIT [min]	St. Dev. [min]
0.000	1.00	0.02	1.13	0.18	1.28	0.87
0.007	18.53	0.94	17.35	0.54	2.45	0.19
0.016	22.67	0.93	22.45	0.64	2.37	0.09
0.046	32.31	0.87	30.22	1.51	4.18	0.14
0.105	39.76	0.95	36.83	0.46	6.99	1.19
0.255	51.39	0.46	46.12	0.22	16.52	0.26
0.281	53.49	0.64	49.23	0.49	19.19	1.43

Uses

- Quality control
- R&D screening
- Qualitative ranking of stabilized materials
- Thermal history analysis

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We work with clients throughout the product life cycle to:

- **Develop new materials**
- **Design prototypes for proof-of-concept studies**
- **Create and execute experimental design**
- **Validate and verify manufacturing processes**
- **Perform root-cause analysis in product failures**

Cambridge Polymer Group, Inc. was founded in 1996 to provide a cost-effective resource for testing, research and development to clients who need periodic access to Ph.D.-level scientists and their support structure. We have developed a host of testing methods and materials for our clients, which number more than 300.

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