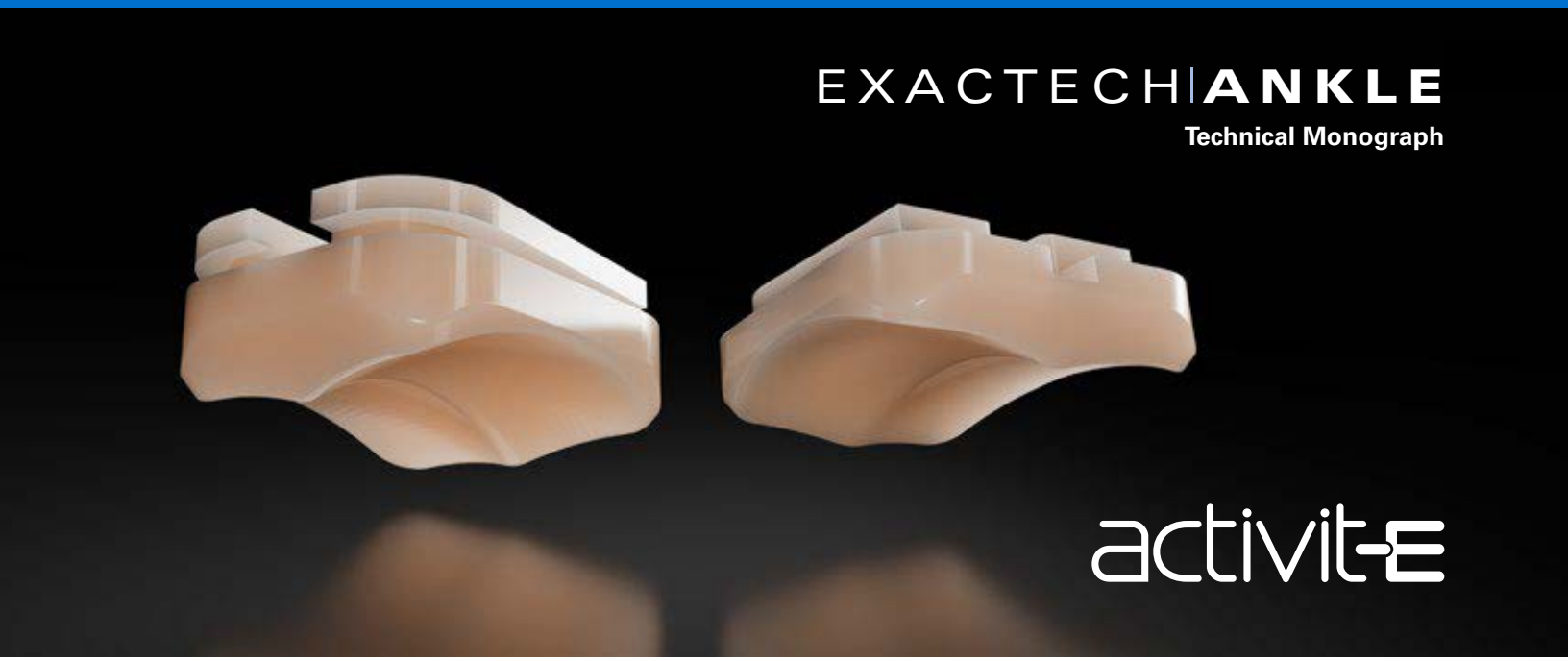
EXACTECH | ANKLE

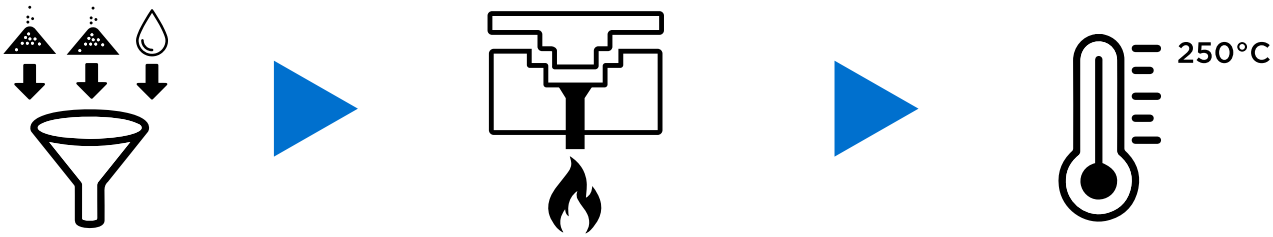
Technical Monograph



Activit-E is a next-generation highly crosslinked polyethylene with vitamin E antioxidant stabilization. Its unique manufacturing process replaces gamma irradiation crosslinking with peroxide crosslinking and adds vitamin E to provide strength, flexibility, toughness and oxidative stability.[2] This technology also ensures patients have access to highly crosslinked polyethylene despite anticipated shortage of gamma radiation for crosslinking.

Activit-E was developed by Orhun Muratoglu, Ph.D., director of the Harris Orthopaedic Laboratory at Massachusetts General Hospital in Boston, and his team, including Ebru Oral, Ph.D, director of Biomaterials Research. Muratoglu and his team invented the first generation highly crosslinked polyethylene, and Muratoglu, together with Oral, pioneered Vitamin E stabilization in highly crosslinked polyethylenes that are in clinical use worldwide.

Manufacturing Process



BLEND
UHMWPE
Peroxide
Vitamin E

COMPRESSION MOLD
Consolidation and crosslinking occur during molding

HTM
High temperature melting to increase toughness and remove by-products

Crosslinked Polyethylene Generations:

In search of improved wear resistance, UHMWPE has historically been crosslinked using ionizing radiation (HXLPE). While improvements in wear properties were realized, crosslinking reduces the mobility of the polymer chains resulting in a reduction in ductility and toughness of the material as compared to conventional UHMWPE. Additionally, free radicals generated from the exposure to ionizing radiation threaten to cause oxidation which further reduces material properties and damage resistance.[1] Various downstream post processing treatments meant to alleviate the oxidation potential due to free radicals were subsequently introduced.

First Generation:

First generation HXLPEs were stabilized against oxidation using thermal methods such as annealing and remelting of the material each with its own compromises. Annealing does not quench all free radicals present in the UHMWPE because the free radicals trapped in the crystalline region of the polymer remain. Remelting offers the ability to quench all free radicals however further degradation of mechanical properties occur due to resultant reduction in crystallinity. More contemporary research has shown that thermal treatment of UHMWPE alone only passively addresses the problem of oxidation. Additional mechanisms such as cyclic stress and absorbed lipids from synovial fluid contribute to oxidation of the material in vivo giving rise to second generation HXLPEs designed to address this concern.[1]

WEAR RESISTANCE	OXIDATION RESISTANCE	DUCTILITY AND TOUGHNESS
☑	☒	☒

Second Generation with Antioxidant Stabilization:

The second Generation HXLPEs were introduced to solve the issue of oxidation by incorporating antioxidants to scavenge free radicals and stabilize the material. The most common antioxidant used for this purpose is vitamin E. While antioxidant stabilization allows for optimizing wear resistance and maintenance of mechanical properties for the long term, the ductility and toughness of the material remains on the level of first generation highly cross-linked polyethylenes.

WEAR RESISTANCE	OXIDATION RESISTANCE	DUCTILITY AND TOUGHNESS
☑	☑	☒

Third Generation:

Introducing Activit-E, the world's first third-generation UHMWPE featuring antioxidant stabilized chemically crosslinked UHMWPE. Activit-E retains the benefits of optimizing wear reduction and active stabilization with Vitamin-E seen in second generation HXLPEs but offers superior mechanical properties. Chemical crosslinking UHMWPE affords the unique ability to optimize wear resistance, oxidative stability, and mechanical properties of the material as compared to the second generation irradiation cross-linked material.

WEAR RESISTANCE	OXIDATION RESISTANCE	DUCTILITY AND TOUGHNESS
☑	☑	☑

Highlights:

- Over 90% reduction in wear volume relative to standard UHMWPE (data on file at Exactech).
- Enhanced oxidative stability as demonstrated with Oxidation Induction Time.[2]
- Enhanced wear resistance without compromising ductility and toughness.

Material[2]	OIT (min)[2]
Conventional UHMPWE	<1
Activit-E®	27.5 ± 4.3

References

1. **S. M. Kurtz,** UHMWPE Biomaterials Handbook: Ultra High Molecular Weight Polyethylene in Total Joint Replacement and Medical Devices. Academic Press, 2009.
2. **O. K. Muratoglu et al.,** "Di-cumyl peroxide cross-linked UHMWPE/vitamin-E blend for total joint arthroplasty implants," J. Orthop. Res., vol. n/a, no. n/a, doi: 10.1002/jor.25679.