



Standard Test Method for In Situ Determination of Network Parameters of Crosslinked Ultra High Molecular Weight Polyethylene (UHMWPE)¹

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1. Scope

1.1 This test method describes how the crosslink density, molecular weight between crosslinks, and number of repeat units between crosslinks in ultra-high molecular weight polyethylene (UHMWPE) crosslinked by ionizing radiation or by chemical means can be determined by measuring the swelling ratio of samples immersed in o-xylene. Examples of experimental techniques used to make these measurements are discussed herein.

1.2 The test method reported here measures the change in height of a sample specimen while it is immersed in the solvent. Volumetric swell ratios assume that the sample is crosslinked isotropically, and that the change in dimension will be uniform in all directions. This technique avoids uncertainty induced by solvent evaporation or temperature change.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

¹ This test method is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.15 on Material Test Methods.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *crosslink density*, v_d —the theoretical average number of crosslinks per unit volume [mol/dm³].

3.1.2 *molecular weight between crosslinks*, M_c —the theoretical average molecular weight between crosslinks [g/mol].

3.1.3 *swell ratio*, q_s —the ratio of the volume of the sample in an equilibrium swollen state to its volume in the unswollen state.

4. Summary of Test Method

4.1 The height of a cubic specimen is measured, and the specimen is placed in a dry chamber. A selected solvent is chosen according to the Flory network theory and is introduced into the chamber. The chamber is heated to the reference temperature. The sample height is monitored as a function of time until steady state (equilibrium) is achieved. The swell ratio is calculated from the final steady state (equilibrium) height and the initial height.

5. Significance and Use

5.1 This test method is designed to produce data indicative of the degree of crosslinking in ultra high molecular weight polyethylene that has been crosslinked chemically or by ionizing radiation.

5.2 The results are sensitive to the test temperature, solvent, and method used. For the comparison of data between institutions, care must be taken to have the same test conditions and reagents.

5.3 The data can be used for dose uniformity analysis, fundamental research, and quality assurance testing.

6. Apparatus

6.1 The apparatus shall include any device that allows a non-invasive measurement of the change in one dimension of the sample as it swells in the solvent. This measurement could include, but is not limited to:

6.1.1 Mechanical measurements, such as linear variable displacement transducers (LVDTs).