PolyFacts

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Monomers & Polymers

News | Views | Insights *from*

Polysciences, Inc.
Chemistry beyond the ordinary

New!

Hydrophilic PEG Monomers and Macromonomers

Polysciences is proud to announce the introduction of new hydrophilic poly(ethylene glycol) (PEG) containing monomers to our product line.

Two of these products represent a new category of methacrylate macromonomers containing both PEG and poly(propylene glycol) (PPG) units while others expand our existing lines of mono and di-functional PEG monomers and crosslinking agents.

Increasing the hydrophilic properties of polymers is often necessary in applications where transmission of moisture and oxygen is required such as in ophthalmic lenses (*both contact lenses and intraocular lenses*), membranes, biomedical devices (*e.g. topical dermal patches*), breathable coatings, and other high value-added applications. To allow optimizing the hydrophilic nature of these materials along with their mechanical and physical properties, Polysciences offers a range of monomers capable of imparting hydrophilicity. PEG containing materials have been especially popular for these applications due to the fact that these materials offer good water solubility while being non-ionic and biocompatible. The new PEG-containing monomers and macromonomers we now offer provide unique options and expanded opportunities to tune polymer properties to meet the needs of a variety of applications.

Poly(propylene glycol) (PPG) is a polymer that is less hydrophilic than poly(ethylene glycol) and PEG-PPG block copolymers have been shown to provide unique properties relative to either of the homopolymers. The different solubility of the materials comprising the two blocks allows unique moisture retention and wetting capabilities, and can lead to gel and micelle formation with changes in pH or temperature. Polymerizable versions of these materials have been shown to be useful for drug encapsulation and delivery, formation of hydrogels,

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construction of nanocomposites and stabilization of biodegradable nanoparticles. **Table 1** shows the structures of the first methacrylate containing materials in this class now offered by Polysciences. The core structures of these macromonomers (core = without the methacrylates) have been shown to have the lowest toxicity for these types of materials and the core of Cat. #25430 has been FDA approved as a food and drug additive. While these materials are water soluble on their own, the methacrylate functionalities allow them to be polymerized to provide insoluble hydrophilic structures.

In addition to these materials, we have also expanded our line of monofunctional and difunctional PEG containing monomers to include higher molecular weights. These materials allow tuning the mechanical properties of PEG containing polymers, preparing comb and brush polymers, and controlling the spacing between crosslinked segments within hydrogels.

2-Hydroxyethyl methacrylate (HEMA), which represents the parent structure of our PEG-methacrylate product line, is perhaps the most widely studied and used neutral hydrophilic monomer. The monomer is soluble in water, and its homopolymer while water-insoluble is plasticized and swollen in water. This monomer is the basis for many hydrogel products such as soft contact lenses, as well as polymer binders for controlled drug release, absorbents for bodily fluids and lubricious coatings. As a co-monomer with other ester monomers, HEMA can be used to control hydrophobicity or introduce reactive sites. Due to the importance of this monomer in various applications, Polysciences offers several grades of this material to accommodate the research and production needs of different industries and applications, see **Table 2**.

To allow further tuning to properties of hydrophilic polymers, we also offer longer chain-length and crosslinkable versions of HEMA. ***These monomers allow tuning polymer properties to obtain the precise balance of water and oxygen transmission rates along with the appropriate mechanical and physical properties for your application***. Materials such as those in **Table 3** contain non-ionic PEG side chains that increase water compatibility in polymers prepared from them and can also enhance stabilization of latex systems when used alone or in combination with other non-ionic surfactants. The higher molecular weight hydroxy terminated compounds can be difficult to obtain due to challenges involved with removing impurities. Polysciences has recently applied our research efforts to identify methods for preparing these useful new analogs in high purity and can now readily provide multigram and **kilogram** quantities of these materials.

Ethylene glycol dimethacryate (EGDMA) is a bifunctional monomer often used to prepare crosslinked hydrogels from monomers such as those described within this article. While this crosslinker often works well, properties of the resulting polymer network can be further tuned by employing crosslinkers with longer chains and/or acrylate functionality. Employing these crosslinking monomers, shown in **Table 4**, allows tuning the rate of crosslinker incorporation as well as the spacing between crosslinked chains and the pore size of the resulting polymer network. Using the crosslinkers with longer PEG chains can provide more precise control of the spacing between chains rather than relying on reaction conditions alone to control the branching structure obtained.

For descriptions and data on our full line of hydrophilic PEG monomers, visit: **www.polysciences.com/hydrophilic**

Table 1: Multifunctional PEG-PPG Methacrylate Macromonomers

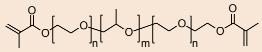
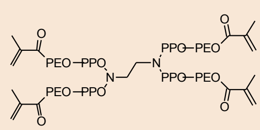
Structure	Cat. #	PPG block MW	PEG block MW	Total MW
	25430 **New!**	3,000	5,800 (2x)	14,600
	25429 **New!**	4,500 (4x)	10,700 (4x)	60,800

Table 2: HEMA Monomers

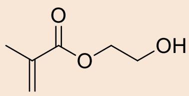
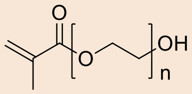
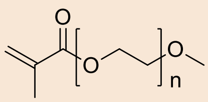
Structure	Cat #	Grade	Specifications
	03699	Low Acid Grade	Purity ≥ 98% Acid Content ≤ 0.10% Color ≤ 30
	04675	Ophthalmic Grade	Purity ≥ 99% Acid Content ≤ 0.05% Color ≤ 30
	00227	Technical Grade	Purity ≥ 97% Acid Content ≤ 1.5% Color ≤ 50%

Table 3: **HEMA-10 and Related Longer PEG Chain Methacrylates**

Structure	Cat. #	MW of PEG Block	Number of PEG Units	End Group
	03699	44	1 (HEMA)	OH
	04675	44	1 (HEMA)	OH
	00227	44	1 (HEMA)	OH
	16712	200	4-5	OH
	16713	400	9	OH
	24890	441	10 (HEMA-10)	OH
	25427 **New!**	2000	45	OH
	02488	44	1	Me
	16664	200	4-5	Me
	16665	400	9	Me
	16666	1000	23	Me
	25426 **New!**	5000	114	Me

NEW!

Polyethylenimine "Max" (Mw 160,000) High Potency Linear PEI *Cat. #25439*

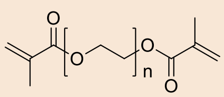
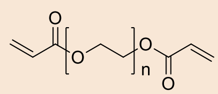
Molecular Weight (Mw)
Mw in free base form. Nominal 160,000 Mw in hydrochloride salt form. (Comparable to Cat. #25414 - Polyethylenimine, Linear, Mw 100,000 which is not in the hydrochloride salt form)

Chemical Structure
Hydrochloride salt of linear polyethylenimine

Solubility
Highly water soluble in hydrochloride salt form

Molecular Weight
100,000

Table 4: **Difunctional PEG Acrylates and Methacrylates**

Structure	Cat. #	End Groups	Structure	Cat. #	End Groups	Acrylates and Methacrylates: MW of PEG block*	Number of PEG units*
	02303	methacrylate (EGDMA)		02302	acrylate	44	1
	02214	methacrylate		02215	acrylate	88	2
	01319	methacrylate		02655	acrylate	132	3
	02654	methacrylate		01668	acrylate	176	4
	00096	methacrylate		00669	acrylate	200	4-5
	15179	methacrylate		01871	acrylate	400	9
	02364	methacrylate		--	acrylate	600	14
	15178	methacrylate		--	acrylate	1,000	23
	--	--		15246	acrylate	4,000	91
	25428 **New!**	methacrylate		--	--	8,000	182
	25406 **New!**	methacrylate		--	--	20,000	455

*MW of PEG block & Number of PEG Units are applicable to both Acrylates and Methacrylates.

Polysciences also has a wide range of related hydrophilic monomers for further tuning the properties of the resulting polymers. These currently available HEMA-related materials will be discussed in detail in future publications with:

- **Longer PEG chains with either alcohol or methyl ether termination (included here).**
- Longer and/or branched alkyl chains.
- Monomers with amides and amines in place of HEMA's ester and ether functionalities.
- Branched versions with a range of molecular weights to allow crosslinking.
- Alternate end groups (epoxy, CN, COOH, PO_3, SO_3, morpholino).
- Versions with allyl polymerizable groups.

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