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## MACROMOLECULAR COMPOUNDS

## FIELD OF INVENTION

The present invention relates to new photoinitiators capable of acting as photocrosslinkers providing a combination of photoinitiating and crosslinking processes.

## BACKGROUND OF INVENTION

The UV curing of resin formulations is widely used in industry as the setting process for coatings, adhesives, and more recently paints. Such formulations may comprise a combination of vinyl, usually acrylate, monomers and crosslinkers, together with a photoinitiator. Other possible constituents of the formulations include crosslinkers and vehicles. In general an advantage of photocurable formulations is that the monomers act as their own vehicle, and the use of solvent is obviated, which has environmental advantages.

Advances in the technology of photocuring, improvements such as, those in UV lamps, cationic initiators for epoxide-based formulations, water borne coatings, and many novel monomers has enabled this production process to penetrate a number of important manufacturing sectors. Photopolymerization is now used in photoresists for printed circuits and microelectronics, for photolithography, magnetic recording media, glass-fiber laminates, and for medical devices, especially for dental and ophthalmic applications.

For the medical applications of photopolymerisation it is usual to employ visible light, rather than UV, to effect the cure of the resin formulation. The use of visible, usually blue, light avoids exposing patient and dentist or surgeon to harmful irradiation. Increasingly the merit of this approach is being recognized for industrial practice, where operatives also need protection from prolonged exposure to harmful UV.

European Patent 0800 657 describes a photoinitiator linked to a macromer structure which together with a copolymerizable monomer and a crosslinker is capable forming a polymerization product, such as an ophthalmic lens that retains photoinitiator radical in the resulting network. This is advantageous in medical applications wherein such potentially harmful radicals must be carefully controlled. However, this system would not be applicable for producing a polymerized product directly in the capsular bag in the eye since it is not directed to photoinitiators activated by light in the visible range, U.S. Pat. No. 4,536,265 discloses siloxane polyphotoinitiators to be used with a curable silicone resin. This system is UV curable and consequently it will not be applicable for photocuring in the living eye.

It is a characteristic of almost all, if not all, of the formulations used for aforementioned types of application that they are crosslinked. Crosslinking of the polymeric bases which constitute the coatings or artifacts of the aforementioned industrial products confers important advantages upon them. Crosslinked polymers have greater environmental (e.g. temperature and moisture) resistance, solvent resistance and dimensional and mechanical stability, than equivalent linear polymers. This is especially so for where the equivalent linear polymer are produced by photopolymerisation they have an atactic, non-crystalline, structure.

Crosslinking is introduced into photopolymerized products by including in the formulation for the resin, coating or gelling system an acrylate, or similar, crosslinker, which is

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characterized by having two or more crosslinkable acrylate or vinyl functions. In some formulations this crosslinking species is a polymer of low molecular weight. The crosslinker copolymerizes with the monomers of the formulation to produce a network structure.

It is the object of the present invention provide compounds which act as photocrosslinkers for vinyl, acrylate and methacrylate monomers and acrylated silicone compositions, especially in solution.

It is also an important object of the present invention to provide photocrosslinkers with capability to act in aqueous solutions, especially on water soluble macromolecular particles having functional groups for crosslinking.

It is another object of the present invention to provide photocrosslinkers with enhanced photoactivity (100% conversion of monomer to polymer in aqueous solution) which reduces photoinitiator residues to a minimum, especially, vinyl modification of photoinitiator component and thereby reducing compositional drift, Draize and other environmental hazards.

The invention as presented below will explain how the mentioned objects are met while discussing further obvious advantages.

## DESCRIPTION OF THE INVENTION

The present invention pertains to macromolecular hydrophilic photocrosslinkers having a general formula  $(A)_n(B)_m(C)_p$ , wherein

- (i) A, B and C are units of substituted ethylene or siloxane groups in the macromolecular structure;
- (ii) A, B and C are randomly distributed and the unit C carries a photoactive group;
- (iii)  $n=0-98$  mole %,  $m=0-98$  mole %,  $n+m=50-98$  mole % and  $p=0.5-50$  mole %.

When the photoactive groups of units C are exposed to light of determined wavelengths above 305 nm, radicals are generated which are retained on the macromolecular photocrosslinkers and will react to form a crosslinked network structure. Preferably the final structure is solid article.

The photocrosslinker further preferably further comprises functional groups for crosslinking. Such groups are conventionally vinylic, acrylic or methacrylic groups and their nature and introduction on polymeric backbone are well known to persons skilled in the art and will be referred to as "functional groups for crosslinking".

According to one aspect of the invention a fluid composition of the photocrosslinker in a suitable amount can be directly crosslinked into the final solid product upon sufficient irradiation. In another aspect the composition for crosslinking into a solid article comprises suitable amounts of the photocrosslinker and a polymer carrying functional groups for crosslinking. The photocrosslinker in such a system will thereby replace the conventional combination of crosslinker and photoinitiator. Applicable polymers with suitable functional can readily be provided with the skilled person for the purpose of crosslinking desired articles. For example it would be conceivable to employ polymers having a sufficiently high refractive index to be acceptable as intraocular lenses. Suitable polymers can be, for example, be found in International Patent Application PCT/EP99/07718. In a still another aspect of the present invention, the photocrosslinkers can be employed in a composition, preferably an aqueous composition further comprising at least one copolymerizable vinylic, acrylic or methacrylic monomer. Such monomers and combinations thereof are well known in the art and will not be described herein in further detail. It