POLYMERIC NETWORKS FROM WATER-SOLUBLE PREPOLYMERS

The present invention describes a water-soluble crosslinkable prepolymer that comprises, in the copolymer chain, units derived from the following monomeric structural units: a vinyl lactam (a), vinyl alcohol (b), optionally a lower alkanecarboxylic acid vinyl ester (c), a vinylic crosslinking agent (d) and optionally a vinylic photoinitiator (e); a process for the preparation of the novel prepolymers; crosslinked water-insoluble polymeric networks therefrom; hydrogels and moulded articles made from the crosslinked water-insoluble polymeric networks, especially contact lenses; and a process for the manufacture of hydrogels and finished contact lenses using the mentioned crosslinkable water-soluble prepolymers.

Vinyl lactam copolymers, for example vinylpyrrolidone copolymers, have for a long time been known as materials for contact lenses having a high water content. Representative examples that may be mentioned in this connection are Scafilcon A and Surfilcon A. They have proved very successful in practice because they are very comfortable to wear.

U.S. Pat. No. 4,347,198 describes the manufacture of contact lenses; a hydrophilic component, for example N-vinylpyrrolidone, a hydrophobic component, for example methyl methacrylate, a crosslinking agent and an initiator are mixed in a solvent, for example DMSO, and then the mixture is crosslinked in a mould. After extraction and equilibration in water, a soft hydrogel contact lens is obtained. Extraction with water is necessary because the solvent and unreacted vinyl monomers must be removed. Since a polymer swells to different degrees in, for example, DMSO on the one hand and water on the other hand, the contact lens does not assume its final size until equilibration.

EP 216 074 describes a process for the manufacture of hydrogel contact lenses. In that process, a polyvinyl alcohol modified with methacrylate is used, which is copolymerised in DMSO solution with vinyl monomers in a suitable casting mould, for example in the presence of a photoinitiator by irradiation with UV light for approximately 3 hours. After the contact lens has been removed from the mould, it is extracted with water or physiological saline in order to remove the DMSO and unreacted vinyl monomers. In this case too, the contact lens acquires its final geometry at the last stage on account of the differing effects of DMSO and water on its swelling.

Various attempts are being made to shorten the reaction times in the preparation of polymers in order to render the manufacture of lenses more efficient. EP 370 827 (Vistakon) describes, for example, the use of boric acid esters of particular difunctional alcohols as solvents for the polymerisation of, essentially, hydroxyethyl methacrylate (HEMA) in a polystyrene casting mould. The polymerisation again takes place in the presence of a photoinitiator by irradiation with UV light in only 6 to 12 minutes, and yields a gel which must then be extracted with water.

One disadvantage of the processes hitherto known for the manufacture of contact lenses is the lengthy extraction with water or physiological saline, which makes impossible the efficient manufacture of contact lenses with short cycle times.

Another disadvantage of the previous processes, as already mentioned, is the relatively low ram of crosslinking in the preparation of polymers in the prior art.

The present invention provides a solution in that respect. It discloses prepolymers that are both water-soluble and crosslinkable. The above-mentioned lengthy extraction with water or physiological saline after crosslinking is dispensed with in the present invention, since crosslinking can be carried out in, for example, water. The disadvantage of the relatively low rate of crosslinking is countered by using as starting materials for the manufacture of contact lenses not monomers but crosslinkable prepolymers.

Accordingly, the present invention relates to a water-soluble crosslinkable prepolymer that comprises, in the copolymer chain, units derived from the following monomeric structural units: a vinyl lactam (a), vinyl alcohol (b), optionally a lower alkanecarboxylic acid vinyl ester (c), a vinylic crosslinking agent (d) and optionally a vinylic photoinitiator (e).

Within the scope of the present Application, a water-soluble crosslinkable prepolymer is to be understood as being both a crosslinkable prepolymer and an uncrosslinked prepolymer.

The present invention relates preferably to a water-soluble crosslinkable prepolymer that comprises, in the copolymer chain, units derived from the following monomeric structural units:

from 5 to 85% by weight of a vinyl lactam (a),
from 3 to 80% by weight of vinyl alcohol (b),
from 0 to 65% by weight of a lower alkanecarboxylic acid vinyl ester (c),
from 3 to 40% by weight of a vinylic crosslinking agent (d) and
from 0 to 5% by weight of a vinylic photoinitiator (e).

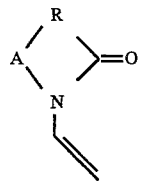
The present invention also relates preferably to a water-soluble crosslinkable prepolymer that comprises, in the copolymer chain, units derived from the following monomeric structural units:

from 10 to 75% by weight of a vinyl lactam (a),
from 10 to 65% by weight of vinyl alcohol (b),
from 2 to 40% by weight of a lower alkanecarboxylic acid vinyl ester (c),
from 5 to 35% by weight of a vinylic crosslinking agent (d) and
from 0 to 3% by weight of a vinylic photoinitiator (e).

The present invention relates preferably to a water-soluble crosslinkable prepolymer that comprises, in the copolymer chain, units derived from the following monomeric structural units:

from 20 to 70% by weight of a vinyl lactam (a),
from 15 to 60% by weight of vinyl alcohol (b),
from 5 to 30% by weight of a lower alkanecarboxylic acid vinyl ester (c),
from 7 to 30% by weight of a vinylic crosslinking agent (d) and
from 0 to 2% by weight of a vinylic photoinitiator (e).

According to the invention, a vinyl lactarn (a) is to be understood as being, for example, a five- to seven-membered lactam of formula (I)



(I)

wherein

R is alkylene or alkenylene having from 2 to 8 carbon atoms that is linear or has one or more branches, and

A is CO or CR^1R^2, wherein R^1 is hydrogen, lower alkyl, aryl, aralkyl or alkaryl and R^2 is hydrogen or lower alkyl.