and/or support infill. Such processes can however be difficult to accurately control, due to the variability of materials offered for recycling. Furthermore, completely recyclable or degradable materials are desirable to prevent the introduction of plastics into the environment that may persist and cause pollution. The pollution caused may be the result of proliferation of micro-plastics into the environment which pose a potential health risk to human and animal health.

Micro-plastics are defined by the European Chemicals Agency (ECHA) as materials consisting of solid polymer containing particles, to which additives or other substances may have been added, and where ≥ 1% w/w of particles have (i) all dimensions 1nm ≤ x ≤ 5mm, or (ii), for fibres, a length of 3nm ≤ x ≤ 15mm and length to diameter ratio of >3. Such micron scale pieces of plastic may remain in the environment after the mechanical break-down of larger pieces of plastic that have been littered or dumped. Micro-plastics have been shown to travel up the food chain and have the potential to cause severe health problems as they tend to accumulate in the internal organs of a human or animal.

It would be desirable to provide an improved infill that alleviates at least some of the problems inherent to existing infill materials.

SUMMARY OF THE INVENTION

According to a first aspect, there is provided a natural binder-based infill for artificial turf manufactured through an extrusion process, the infill comprising biodegradable granules, wherein the granules comprise a natural binder that has been physically but not chemically modified by the addition of a quantity of filler material and an anti-tack agent mixed and dispersed throughout the granule, wherein the granules have a mean size of between 0.2 mm and 5 mm.

One form of natural binder is rubber. Natural unvulcanised rubber is a polymer that has been polymerized in nature. It may sometimes be referred to as natural latex and is primarily derived from the Hevea Brasilens or rubber tree. Polymers that occur in nature, as long as their chemical structure has not been modified, are considered inherently biodegradable in nature. The term “biodegradable” as used herein refers to a material that can be broken down naturally to re-enter the ecosystem once degraded, leaving only naturally occurring materials. This term therefore excludes petrochemical plastics that persist in the environment and cause pollution. This term and other terms referred to hereinafter, will be interpreted in the context of the EU REACH Regulation (Regulation No1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals).

In conventional processes, natural rubber is vulcanised or otherwise cross-linked by the addition of a suitable cross-linking additive such as sulphur. The resulting rubber product is

cork, corn and other similar natural materials are their resistance to aging and tearing, resilience to adverse weather conditions, and being sufficiently dense to provide a stabilising weight to the infill. Furthermore, these materials do not absorb heat as much as polymeric infill and thereby provide a cooler turf system in use.

According to a further embodiment, the granules may comprise a mixture of different binders or binding agents, which will all be naturally occurring materials. This may include a biodegradable material such as plant starch. This again provides the advantages of being sourceable from waste products and being devoid of micro-plastics. Natural rubber is another binding agent that is well known for its elastic properties and can help to form a stable granule. The skilled person will be familiar with the properties of other possible binding agents, which may include gums, oils, proteins, waxes and the like.

As indicated above, the granule may comprise various relative amounts of natural binder, filler material and further optional components as determined by the required properties. In one embodiment, the granule comprises from 10 to 80 wt % of filler and from 10 to 50 wt % binder, more preferably from 20 wt% to 40 wt% binder.

In certain embodiments, the granules may comprise inclusions, having a size of between 10% and 90% of the granule. In this context ‘inclusion’ is used to denote a particulate or body that is large compared to the granule i.e. smaller than the granule but of a similar order of magnitude. The inclusions may be formed of the same material as the filler materials and their volume may be taken into account together with that of the filler material. In some embodiments, there may be precisely one inclusion per granule.

In particular, the inclusions may be relevant to the method of manufacture of the granules. They may be mixed into the precursor material from which the granule is formed e.g. by extrusion. The mixture can take place by conventional mixing methods e.g. using screws and hoppers to deliver the respective components and may take place prior to or during an extrusion process. Alternatively, each granule may comprises a layer of natural binder coated onto one or more surfaces of an inclusion, forming a core of the granule, e.g. by a dipping process or the like.

As indicated above, the anti-tack agent renders the granules tack resistant, preventing individual granules from sticking together during production, storage and/or use. In preferred cases, the resulting granules should be loose and free flowing at all temperatures where use is required, in particular between -10 C and 80 C, since outdoor sports surfaces can readily reach since elevated temperatures when exposed to the sun. It is however contemplated that usable

infill for indoor or covered purposes could be adequately tack resistant if tack resistant to temperatures of 50 C.

In this context, tack resistant may be defined to comprise granules that are not tacky at temperatures below 50 C, more preferable below 60 C, more preferably below 70 C and most preferably below 80 C. Tackiness for this purpose is assessed by heating a sample in a dish (about 5 mm layer thickness) overnight in an oven at the relevant temperature. The sample is subsequently cooled down and the granules are assessed. If the granules are still loose granules, or can be set free by slight agitation, then the sample is judged as not tacky. If, on the other hand, the granules form a cake, this is judged as tacky or not tack resistant. The highest temperature where the granules remain non-tacky is denoted as the tackiness temperature.

According to another embodiment, the granule is preferably resilient, with a Shore A hardness of between 20 and 90, or between 30 and 70, preferably between 40 and 60 optionally around 50. The skilled person will be well aware of how to achieve the desired ranges by the addition of the filler materials mentioned above. In this context, it is noted that the resilience of natural binders is distinct from that of e.g. vulcanised rubber, where the nature of the cross-linking that can significantly influence the elastic performance. In general, natural binders with little filler material will remain have a lower hardness value. As filler material is added, the hardness will increase. Ideally, the granules will have a hardness close to existing synthetic rubber granulate used for infill. Nevertheless, due to the constraints of using natural materials, requiring greater quantities of filler material, higher hardness values may be expected.

In the present context, it is understood that resilient refers to the material property that the material can be deformed upon application of an external force and will spontaneously return to its original shape when the force is removed. This behaviour can be fully elastic by which it is meant that the material returns to its original shape quickly when the force is removed and that the material substantially returns all energy which was needed to deform the material. However, preferably it is viscoelastic by which it is meant that the material only slowly returns to its original shape (in contrast to ‘typical’ fast responding rubber infills) and that it does not give back all the energy needed to deform the material. In an embodiment, the granules exhibit an energy restitution that is less than that of SBR, preferably less than 40% measured on an equipment turf system according to FIFA method 13 (Handbook of Test Methods October 2015 Edition – Version 3.1 16/03/2020).

The present invention also relates to an artificial turf system comprising a quantity of infill as described above or hereinafter. It will be understood that the resulting system on which sport may be practiced is dependent not only on the infill but also on other factors such as the