Development of Technology that Enables Recycling and Traceability of Waste Clothes That Have Reached the End of Their Life by Biochemical and Mechanical Methods

Environmental pollution is the destabilization of the ecological balance of wastes that arise as a result of all kinds of activities of humans. Environmental pollution consisting of industrial waste started in 1760 with the Industrial Revolution, which began with the invention of the steam generator. At that time, the release of flue gases formed as a result of burning the coal used for energy into the atmosphere without filtration and the sulfur dioxide contained in the flue gas then came into contact with the rainwater and returned to nature as sulfur acid, destroying the vegetation. It continued to increase with the developments in industrialization.

In our world of approximately 7.8 billion people, with the rate of population growth, an intense consumption and therefore waste occurs in every sector due to the fact that the concept of unnecessary, excessive and crazy consumption cannot be prevented, and due to hygiene concerns with increased pollution. Today, these wastes have become serious problems in the oceans or agricultural areas, and non-recyclable waste is disposed of by burial or burning in the ground along with other household wastes (landfill). Among other wastes, it is estimated that approximately 30,000,000 Tons of textile and apparel waste are buried in the ground each year, and about 10,000,000 Tons are disposed of by burning. However, it is estimated that approximately 1,000,000 Tons of used clothing and textiles are recycled. However, only 100,000 Tons of this amount is re-outfitted or textile, and the remaining 900,000 Tons are felted and used as insulation material.

To the extent that it can be collected with this method that we have developed, approximately 20,000,000 Ton of cotton per year can be recovered by clothing recycling and will contribute greatly to the need for resources for future generations. Recycling is a method we have traditionally used to prevent waste of potentially useful natural and polymeric materials by reducing the need for waste disposal and greenhouse gas emissions as well as water consumption. For this purpose, used and unused (defective, faulty) waste clothing is collected as a result of industrial and personal use. Collected waste clothing usually does not consist of a single raw material. It is produced from mixtures of various raw materials such as polyester, nylon, cotton. In addition, the sewing places of the suit are usually formed from synthetic yarns, while the accessory parts are made of raw materials such as metal. These accessories are also installed in textile products with the help of synthetic yarns.

The methodology of the technology to be implemented within the scope of this project can be explained as follows. With the help of Near-infrared spectroscopy (NIR), waste textiles will be separated according to the majority of natural and synthetic raw materials. With this innovative method developed, sewing yarns and accessories of waste clothing with a **high cotton ratio** will be treated with biochemical method and removed from cotton. The clothes whose sewing threads and accessories are removed cannot become isolated (as before the garment) and then after the balance on these wastes is separated from the contaminations, buttons, metal accessories, etc., they are rinsed with water and treated in the chemical pool prepared with subsequent organic compounds and sent to the reactors where the color pigments (dyes) and polymers are removed. At the end of the process, the parts that come out of the reactors are rinsed, dried and turned into textile parts consisting of pure cotton.

Thus, the resulting pieces of cotton fabric with an ecru color, textile wastes appliqued with a softening chemical before the process of converting the ecru color cotton fabric into fiber will gain slipperiness and softness. Then textile waste will be passed through openers and turned into fiber. On the other hand, polymer composite will be obtained by mixing polymers obtained from synthetic raw materials released after industrial and personal use in the monitor pigment extruder, which is invisible to the naked eye and sensitive to different wavelengths. This composite carrier will be added to the polymeric material to create synthetic fiber sensitive to different wavelengths. Synthetic fiber sensitive to different wavelengths will be calculated to be a minimum of 100 ppm in the final product and added to the biochemically decomposed and mechanically recycled ecru color opening cotton and mixed in the blending machine. It will then be brought to the form of the comb strip. It will be transferred from the comb machine to the cer machine and dubbed. Traceable yarns will be obtained with open cotton, which we obtain in ecru color with yarn spinning systems. These yarns can be applied through various processes such as weaving, knitting, dyeing, printing, finishing process. Pigments sensitive to different wavelengths will be monitored with the help of ultraviolet and infrared wavelength sensitive lamps that have been introduced into pen form.

EXPLANATION:

Development of technology that enables the recycling and traceability of waste clothes that have reached the end of their life by biochemical and mechanical methods, recycling of used clothes in the case of waste by biochemical methods, removing color pigments and polymeric materials with the help of organic compounds other than standard bleaching processes, recycling waste textiles into fiber form, different wave developed specifically for fiber it can be monitored by the addition of fibers created with tracer pigments sensitive to their size and is related to the creation of sustainable yarn and textile products. The project includes both the biochemical recycling process and sustainable and traceable textile products.

Only 0.1% of the waste textiles produced and used in the world are recycled back into textile products, and the rest are left to the environment as solid waste, buried or burned. Therefore, natural raw material sources are used to produce a new product. Currently, the method applied to recycle clothes is only 100% cotton natural fiber-based clothing, sewing places and accessory parts are cut with scissors and then mechanically recycled. The sewing place and accessory parts are cut away, while the cotton parts of the product are cut with it. This means discarding the potentially usable part. At the same time, due to the manual processing of all these processes, the need for intensive workmanship and the risks of contamination are seen as the biggest obstacle (barrier) to the recycling of used clothing.

Within the scope of this project, various trials have been made to improve both the biochemical recycling process and sustainable and traceable textile products. With the method developed using biochemical additives, these parts are removed by self-removal. Therefore, the parts to be discarded while being cut with this project have been reintroduced to the production cycle by biochemical recycling. With the help of Near-infrared spectroscopy (NIR), waste textiles are separated according to the proportions of natural and synthetic raw materials they contain. In order to be able to recycle biochemically, not only 100% cotton, but also sewing threads and accessories of the waste suit with a high ratio of cotton were treated with biochemical. Another problem that arises during R&D is that the chemical used when treating waste textile product with biochemicals is not distributed evenly on the fabric. This problem was solved by using reactors for the process and by balancing pressure and temperature.

Water and other chemicals used in these stages are treated with advanced biological treatment systems and then fed into the system for reusing. In this way, the sustainability of the water and chemicals used is ensured. Then, with the help of organic compounds, the color pigments and polymeric materials found in waste textiles are completely removed. Textile wastes, which are appliqued with a softening chemical before the process of converting the resulting ecru colored raw material cotton fabric into fiber, gain slipperiness and softness. Then textile waste is passed through guillotines, brisk garnets or radial openers and converted into fibers.

On the other hand, polymer composite masterbatch is obtained by mixing polymers obtained from synthetic raw materials released after industrial and personal use in extruder between 220 °C and 300 °C temperatures, which are not visible to the naked eye (UV-A: 315 nm-400 nm, UV-B: 280 nm-315 nm, UV-C: Ultraviolet wavelengths such as 100 nm-280 nm and infrared wavelengths such as IR-A: 700 nm-1400 nm, IR-B: 1400 nm-3000 nm, IR-C: 3000 nm-1 mm) by 0.01% to 50% in total weight. This composite masterbatch carrier is added to the polymeric material by 0.01% to 50% and synthetic fiber is created sensitive to different wavelengths. Synthetic fiber sensitive to different wavelengths is calculated to be a minimum of 100 ppm in the final product, adding biochemically decompoted and mechanically recycled ecru color opening cotton and mixed in the blending machine. After being scanned in the comb machine and brought to the form of a comb strip, 2 passages are dubbed in the cer machine. Then the yarn is brought into the form of yarn with spinning systems. Thus, traceable yarns are obtained with the opening cotton that we obtain in ecru color. Yarns containing tracer pigment sensitive to different wavelengths are then passed through various processes such as weaving, knitting, dyeing, printing, finishing process. These fabrics are capable of being used in apparel and home textile products. Ultraviolet and infrared wavelength sensitive lamps are used to monitor tracer pigments sensitive to different wavelengths. These lamps are designed in the form of pens to be easy in terms of portability and usability. When the fiber obtained by pressing the small button on the pen is held on the yarn or textile product, it emits light by shining in the color placed inside. With this technology, sustainable textile product monitoring is ensured.

Sustainability and circularity, which is the mother tongue of nature, are not only issues that sectors pay attention to, but also issues that individuals should be aware of social responsibility. For this purpose, industrial symbiosis will be carried out with the collaborations between companies with this project. In other words, the waste released from the big brands will be the raw material for us. Within the scope of this project, products with high added value will be obtained from these wastes with traceable properties. If these wastes released after industrial and personal use are not recycled in a closed cycle, virgin raw materials will be used and greenhouse gas emissions, energy uses and water consumption of new products will harm nature, increase environmental risks and cause climate change. These situations will also indirectly damage the blue and green economy. With this project, blue and green economy will be directly contributed. Another important aspect of this project is its regenerative design. With regenerative design, we imitate nature as a kind of biomimicric by renewing or re-using our own energy and material sources. So that cyclicality, which is natural, is industrially mimicked. In this way, a closed production cycle will take place. With this project, employment doors will be opened to many people with different technical characteristics working in the field of machinery, chemistry, textiles, electrical and electronics.

Project Team

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Zafer KAPLAN, chairman of the Board of Directors of Gama Recycle Sustainable Technologies Inc., worked in the garment industry in London between 1987 and 1988. In 1989, he worked as a Foreign Trade Officer at a garment company with a Joint South Korean-Turkish investment in Istanbul. In 1991, he started to work as Sales Manager at the company that represents machinery manufacturers in Turkey in various countries such as Germany, Czech Republic, Switzerland and Italy. During this period, he gained valuable experiences about domestic and international markets and signed important projects. He was elected as the Chairman of the Board of Directors of the American Turkish Business Development Council in 2022.

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