The tribological behaviour of aged polymer fibres for gillnets

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Discarded, lost, or abandoned fishing gear continues to fish the oceans year after year, resulting in a "hidden harvest" of fish and shellfish. This results in poor animal welfare, wasted resources, and causes significant harm to coral reefs and other marine life by releasing significant portion of microplastics. To reduce the effect of ghost fishing, novel biodegradable gillnet materials are being developed which degrade faster than conventional fishing net materials. The new materials will still produce microplastic as part of the degradation process. But because it degrades faster the long-term environmental impact might be reduced.

In this study tribological and mechanical testing of gillnet materials made of biodegradable polybutylene succinate co-adipate-co-terephthalate (PBSAT) and conventional polyamide (PA6) resins were performed in the lab scale. In order to identify the role of polymer aging and UV light exposure, both materials were aged according to the ISO 4892-2 weathering cycle norm for 600h and 1000h. Untreated and aged PA6 and PBSAT polymer monofilaments were tribologically tested using a reciprocating TE38 test rig (Phoenix Tribology), where 10 mm in diameter SiC cylinder was pressed against the polymer wire with 0.1N force for the course of 3 min. Tribological investigations were performed in both dry and lubricated (seawater) test conditions. After the test, optical 3D microscopy was performed to identify the extent of wear. To identify the mechanical changes of PA6 and PBSAT after the aging process, the nanoindentation of polymers was performed using Hysitron triboindenter TI950 of both untreated and aged (1000h) monofilaments.

The microhardness testing on the cross section of polymer monofilaments revealed that PBSAT material had lower near-surface elastic modulus values after the aging process as compared to the untreated material. At the same time a significant increase of elastic modulus was seen for the PA6 monofilaments, indicating chemical changes of the monofilaments during the UV exposure cycles. Friction and wear data of PBSAT monofilaments showed a trend that contrasted with the hardness tests, with an increase in the severity of damage to monofilaments exposed to longer aging time. Such trend was however only observed for the tests performed in the dry contact. The hardness testing also revealed that PA6 monofilament after the aging process obtained equal E-modulus across its diameter (same E-modulus near surface as in the core of the monofilament), whereas in the case of PBSAT the E-modulus of the core was always higher than in the near surface region. For both PBSAT and PA6 lubricated with seawater the frictional forces were on similar level (approx. 0.6N) together with the extent of wear.

Keywords: Friction and wear, nanoindentation, accelerated aging, PBSAT and PA6 fibers, monofilaments, biodegradable gillnets.

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