Does Electrocoagulation Provide an Efficient Solution for Removing Microplastics from Synthetic Seawater?

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Abstract

Microplastics (< 5 mm) are widely present in seawater due to extensive plastic use, thus posing a serious risk to marine ecosystems. Electrocoagulation has emerged as an effective removal method, with its success influenced by particle properties and operational parameters. In this study, electrocoagulation was used to remove glitter-type microplastics from synthetic seawater. Particle size was determined using optical microscopy, and seawater composition was characterised by XRF analysis. Removal efficiency was evaluated using aluminium electrodes (AA6063), with a spacing of 2.5 cm, a constant current of 0.3 A, pH values of 5.5–7.5, and a treatment duration of 15–120 min. Removal efficiency increased with treatment duration and reached 62.5 %, 84.14 %, 75.82 %, and 77.12 % after 0.5 h, 1 h, 1.5 h, and 2 h, respectively. Optimal conditions were achieved after one hour, when a maximum efficiency of 84 % was recorded at pH 5.95 and salinity 28.9 ppt. The results confirm the potential of electrocoagulation, and contribute to a better understanding of the mechanisms of microplastic removal from synthetic seawater.

Keywords

Microplastic, electrocoagulation, aluminium electrode, synthetic seawater

1 Introduction

The presence of plastics in seawater is a consequence of the extensive use of plastics both on land and within marine environments. Coastal cities, ports, shipping activities, recreational activities, coastal and near-shore landfills are major sources of plastic pollution in the seas and oceans.[1–3] Plastics provide convenience in daily life and industrial production, but when inadequately managed they also cause severe environmental pollution. Global plastic volumes are expected to increase steadily until 2050 – rising from 464 million tonnes in 2020 to 735.4 million tonnes/year by 2050 based on projected global plastic consumption, and to 884.0 million tonnes/year in 2050 when projections for individual polymer types are summed. Despite anticipated improvements in recycling rates, plastic waste generation is estimated to double by 2050.[4] Plastics are found throughout the seas and oceans due to transport processes such as surface drift, vertical mixing, stranding, and settling.[5,6] Once released into the marine environment, plastics are extremely persistent, with degradation times extending over several centuries. Through prolonged environmental exposure, macroplastics (>25 mm) undergo physicochemical weathering, primarily through mechanical abrasion and photodegradation, leading to their fragmentation into mesoplastics (5–25 mm), microplastics (1–5 mm) and nanoplastics (1 nm–1 μm).[7] These materials are synthetic organic polymers derived predominantly from petrochemical sources, including polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS), and polyethylene terephthalate (PET), which together account for around 90 % of global plastic production.[8] Microplastics vary in colour, density, and shape, and are generally classified as primary and secondary. Primary microplastics are intentionally produced as small, smooth particles for commercial use, and are often found in cosmetic products such as toothpaste, facial cleansers, eyeliners, soaps, etc. By contrast, secondary microplastics result from the degradation of larger plastic items, including macroplastics and mesoplastics. Items such as plastic shopping bags, food packaging, drinks bottles, bottle caps, car tyres, synthetic textiles, pipes, *etc.*, gradually break down into particles smaller than 5 mm through biological, chemical, or physical processes. Environmental factors, such as intense weathering and mechanical abrasion, contribute significantly to the fragmentation of plastics, leading to secondary microplastics being more abundant in aquatic systems than primary forms.[9] Based on their morphology, microplastics can be further categorised as filaments, microbeads, nurdles, foams, or fragments.[10] Numerous studies have confirmed the presence of microplastics in fish, molluscs, zooplankton, mammals, and seabirds, highlighting their widespread ecological impact.[11–16] In the Arctic Central Basin (ACB), microplastics have been detected in sea-ice cores and in waters beneath ice floes.[12] Microplastic contamination of seas and oceans is now recognised as one of the most pressing global environmental challenges.[11–16]

Electrocoagulation (EC) is an efficient and environmentally friendly technique capable of removing various impurities from wastewater, including heavy metals[17,18], organic compounds[19–21], azo dyes[22,23], phosphates[24], as well as microplastics (MP).[25–28] In this electrochemical process, a

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direct electric current is applied to sacrificial metal electrodes (typically iron or aluminium) to generate coagulating substances *in situ*. These coagulants destabilise and aggregate pollutants such as suspended solids, heavy metals, oils, dyes, and microplastics, facilitating their removal through sedimentation or flotation. As a green technology, EC eliminates the need for additional chemical reagents and reduces secondary pollution. Additional advantages of the EC process include the simultaneous removal of multiple pollutant types, reduced sludge formation compared to conventional chemical coagulation, and ease of automation.[29] EC has previously been applied as a pre-treatment method for seawater desalination to reduce organic and biological fouling in reverse osmosis membranes.[30] To the best of current knowledge, EC can be applied for microplastic removal from wastewater, but its application for the removal of microplastics from seawater has not yet been investigated.

This study examines the application of EC for removing microplastic contaminants from synthetic seawater – a matrix characterised by high ionic strength and chemical complexity. The target contaminants were polymeric microplastic particles commercially known as "glitter", consisting of small, flat, reflective fragments with controlled morphology and varying sizes, shapes, and surface properties. The results demonstrate the potential of EC as an effective treatment method for removing microplastics from saline environments, providing insight into its applicability for mitigating marine pollution.

2 Experimental

2.1 Materials and preparation

Commercially available polyester glitter, consisting of hexagonal flat particles ranging from 200 μm to 3 mm, was used as microparticles (Fig. 1). The microparticles were analysed using an optical microscope MXFMS-BD (Ningbo Sunny Instruments Co. China) to determine average particle size.

Synthetic sea salt for marine aquariums was used to prepare the synthetic seawater. Its chemical composition (Table 1) was determined using an ARL 9900 Intelli Power X-ray fluorescence spectrometer (XRF). To demonstrate the removal of microparticles from the synthetic seawater, ≈ 18 g of synthetic sea salt was dissolved in 600 ml of deionised water (29 g l^{-1}). The mass of microparticles added to the solution was ≈ 6 g. Two aluminium electrodes with dimensions of 21 mm × 59 mm × 14 mm and an active immersion area of 44.24 cm^2 were used. The electrodes were made from aluminium alloy AA6063, with the following chemical composition (in % by weight): 98.91 % Al, 0.56 % Mg, 0.02 % Mn, 0.20 % Fe, 0.38 % Si, and 0.01 % Cr. This alloy is suitable as a sacrificial electrode in the EC process due to its susceptibility to localised corrosion and its weak surface oxide layer.[31] For each experiment, the electrodes were mechanically prepared using a metallographic grinding/polishing machine (Metkon, Bursa, Turkey), by wet grinding with 180, 400, 800, and 1200 grit sandpaper. The surfaces were then cleaned in ethanol for 10 min and in deionised water for 10 min using an ASonic Pro ultrasonic bath (Ljubljana, Slovenia).

Table 1 – Chemical composition of synthetic sea salt
Tablica 1 – Kemijski sastav sintetske morske soli

Composition	Cl	Na	S	Mg	Ca	K	Br	Si
wt %	50.50	25.60	8.67	6.82	5.97	1.82	0.47	0.15

2.2 Electrocoagulation process

For each experiment, 600 ml of synthetic seawater with constant salinity (29 ‰) and conductivity (45.3 mS cm^{-1})

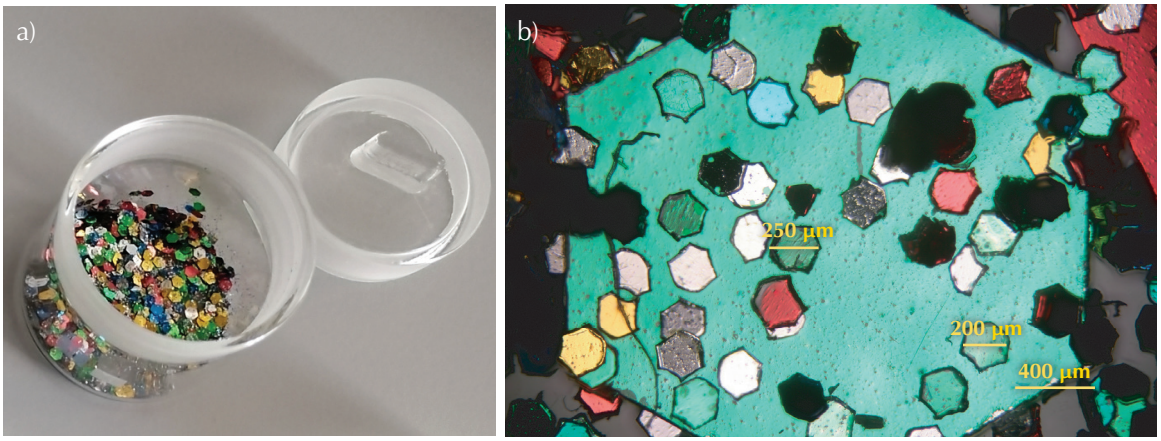

Fig. 1 – a) Commercial polyester glitter, and b) optical microscope image of the particles at 50× magnification
Slika 1 – Komercijalni poliesterski gliter (a) i slika njegovih čestica dobivena optičkim mikroskopom pri povećanju 50× (b)

was used. A pH/conductivity meter (SG23-FK2, Mettler Toledo) was used to measure pH, conductivity, total dissolved solids (TDS), temperature, and salinity of the solution before and after the EC process. A magnetic stirrer (Rotamix SHP-10, Technica) was used to mix and homogenise the suspension. During the experiments, two aluminium electrodes with an active immersion area of 44.24 cm^2 and electrode spacing of 2.5 cm were immersed in the solution. The electrodes were connected to a controllable direct current source (Wanptek DPS605U DC power supply), which supplied the electrical current and regulated the voltage and current during the experiments. The experiments were carried out under constant stirring at a speed of 250 rpm, a room temperature of 21 ± 1 °C, and an applied constant current I = 0.3 A. The process duration was 0.5 to 2 h. The effect of the mass loss of the electrode during the EC process was observed by measuring the electrode mass using an analytical balance (Gold Balance JE155DUG/00, Mettler Toledo) before and after the process. The electrode surfaces were examined using an optical microscope after the EC process to gain a better understanding of the process mechanism. Fig. 2 shows a schematic illustration of the electrocoagulation cell and the electrodes used in the experiment. The experimental conditions were selected based on preliminary tests and optimal conditions reported in the literature for water systems, while a salinity of 29 ppt was used as it approximately corresponds to that of natural seawater.[24–28]

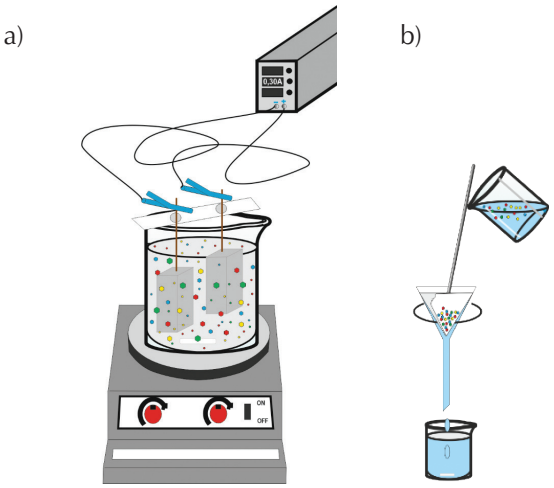

Fig. 2 – Schematic illustration of electrocoagulation: a) cell and electrodes, b) with a funnel for filtering the solution
Slika 2 – Shematski prikaz elektrokoagulacije: ćelija i elektrode (a) s lijevkom za filtraciju otopine (b)

The flocculation phenomenon was observed in the turbidity of the solution, as the particles were initially dispersed within the suspension. After each EC experiment, the electrodes and the magnetic stirrer were removed, and the solution was allowed to settle for 1 h. During this time, some of the microplastics captured within the flocs settled to the bottom of the reactor, while others remained dispersed in the solution. After one hour, a distinct sludge layer was observed at the bottom of the reactor, with a clear layer of supernatant above it, representing the clarified portion of the seawater containing the remaining microplastic particles. The sludge and supernatant were separated and filtered individually using funnels fitted with filter paper. The filter papers were then dried in a dryer (SP-55EASY, Kambič) at 50 °C for 5 h and weighed on an analytical balance to determine the mass of residual microplastic particles in the supernatant, and the mass of flocs and microplastics collected in the sludge. The total removal efficiency of microplastics in the EC process at each time point was calculated using Eq. (1).

$$R = \frac{m_{in} - m_{end}}{m_{in}} \cdot 100 \quad (1)$$

R is the total removal efficiency of microplastics (%), m_{in} is the mass of microplastics in the synthetic seawater at the start of the EC process (g), and m_{end} is the mass of microplastics in the supernatant after the EC process (g). The morphology of the dried sludge was analysed using a scanning electron microscope (JEOL JSM-7610 FPlus), while the products deposited on the surface of the cathode were analysed using energy-dispersive spectroscopy (Oxford ULTIM MAX) to determine the removal mechanisms of the microparticles. A sample was prepared with the same mass of microplastics and the same chemical properties as the synthetic seawater used in the previous experiments, but without current application. The removal efficiency was calculated in the same way as for the samples with current application.

3 Results and discussion

In this study, the electrocoagulation process was used to remove microplastics from synthetic seawater. Synthetic seawater is a highly complex mixture of ions that interact with one another under the influence of an electric current, thereby influencing chemical reactions and electrochemical processes.[32] During electrocoagulation in the water environment, the metal anode (Al) is oxidised by the applied electric current, producing Al^{3+} ions. In contrast, reduction reactions occur at the cathode (Al), generating H_2 and OH^- ions (reaction 3).[25,28,29] The aluminium hydroxide formed (reaction 4) acts as a coagulant that facilitates microplastic removal. According to studies by *Shen et al.*, amorphous flocculants ($[Al(OH)_3]_n$) can be formed as a result of polymerisation of the complex $(Al_m(H_2O) \cdot (OH)_n^{(3m-n)+})$, which is rich in hydroxyl groups on the surface. Flocculants with a low degree of polymerisation remove microplastics primarily through adsorption, whereas highly polymerised flocculants capture and sweep microplastic particles through a netting effect due to their large surface area and numerous functional groups.[25]

Anode:

$$Al(s) \rightarrow Al^{3+}(aq) + 3e^- \quad (2)$$

$$2H_2O(l) \rightarrow 4H^+(aq) + O_2(g) + 4e^- \quad (3)$$

Cathode:

$$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^- \quad (4)$$

$$Al^{3+}(aq) + 3OH^- \rightarrow Al(OH)_3(s) \quad (5)$$

Synthetic seawater contains a high concentration of various ions (Table 1), resulting in several reactions occurring simultaneously during the EC process, with some reaction products depositing on the cathode (Fig. 3).[30,32]

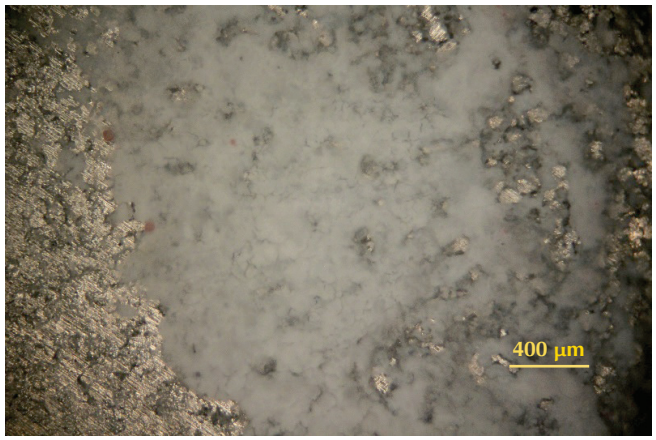

Fig. 3 – Optical microscope image of the cathode surface after 1 h of electrocoagulation at 50× magnification

Slika 3 – Slika površine katode dobivena optičkim mikroskopom nakon 1 h elektrokoagulacije pri povećanju 50×

After just 1 h of the EC process, milky-white, flaky deposits were visible. EDS analysis (Fig. 4b) of the deposits on the cathode shows that ions such as Ca^{2+} and Mg^{2+} in the seawater most likely combined with hydroxide (OH^-) or carbonate ions (CO_3^{2-}), and deposited on the cathode, leading to a decrease in cathode efficiency and overall EC performance. According to the literature, because seawater is rich in Cl^- ions, chloride can also be oxidised at the anode to form chlorine gas (Cl_2), which subsequently hydrolyses to produce hypochlorous acid (HOCl) and may further dissociate to produce hydrogen ions.[32] In seawater, the high concentration of chloride anions should mitigate the effects of carbonate and sulphate ions, and help prevent the formation of calcium and magnesium carbonate/sulphate deposits on the electrode surface.[30]

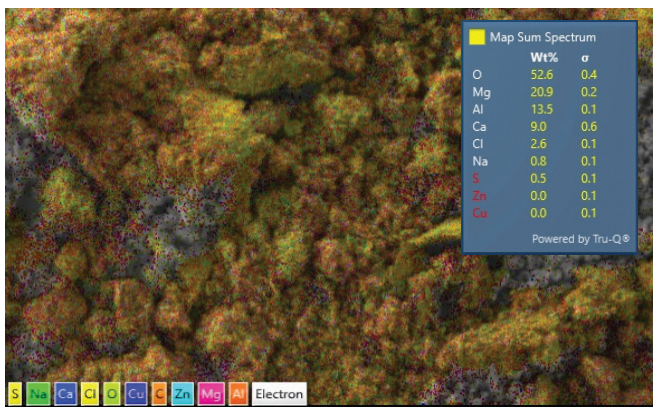

Fig. 4 – SEM image with elemental composition of the products precipitated on the cathode surface during 1 h of electrocoagulation

Slika 4 – SEM slika produkata s elementarnim sastavom istaloženim na površini katode tijekom 1 h elektrokoagulacije

Table 2 shows the physical properties of the synthetic seawater before and after EC process. The pH values were between 8.13 and 8.22, conductivity values between 44.7 and 45.3 mS cm^{-1}, total dissolved solids (TDS) values between 22 and 22.9 g l^{-1}, and the salinity between 28.5 and 29.5 before the EC process. The physical properties of the synthetic seawater were measured at a temperature of 20 to 22.3 °C before the EC process. The values of conductivity, TDS, and salinity did not change significantly after the EC process, while the pH values decreased with increasing time to 6.39, 5.95, 6.18, and 6.08, respectively. According to the literature, during the electrocoagulation process in water treatment using aluminium electrodes, the pH increases due to the formation of OH^- ions (reaction 4).[21,22,25] The observed decrease in pH during the electrocoagulation process in synthetic seawater can be attributed to several mechanisms.[30,32] Hydroxide ions generated at the cathode can react with calcium and magnesium to form insoluble precipitates, which reduce the effective cathode surface area. Additionally, at high current, chloride ions can be oxidised at the anode to produce chlorine gas (reaction 6). This chlorine subsequently hydrolyses to form hypochlorous acid, which can further dissociate to release hydrogen ions, thereby contributing to a decrease in pH (reactions 7 and 8).[30,32]

$$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^- \quad (6)$$

$$Cl_2(g) + H_2O \rightarrow HOCl(aq) + HCl \quad (7)$$

$$HOCl(aq) + H_2O \rightarrow H_3O^+ + OCl^-(aq) \quad (8)$$

The pH values of the synthetic seawater during the EC process ranged from 5 to 7, which is the optimal range for producing various Al hydroxide ions, as previously published studies have shown.[33, 34] After one hour of the EC process, the lowest pH value of 5.95 was observed in the synthetic seawater. The absence of a further decrease in pH with increasing duration of electrocoagulation may indicate that the EC process had reached a phase of decreasing efficiency. During the EC process, the increase in temperature has a considerable influence on electrode reactions, flocs formation, hydroxide solubility, and ionic conductivity of the electrolyte solution.[35] With increasing duration of the EC process, a slight increase in temperature was observed, which may have resulted from chemical and electrochemical reactions.

In addition, the relationship between MP removal efficiency and EC process duration in synthetic seawater was investigated to determine the optimal process duration. The EC process was carried out under constant stirring at 250 rpm, at room temperature (21 ± 1 °C), with a fixed

Table 2 – Physical properties of synthetic seawater before and after electrocoagulation
Tablica 2 – Fizikalna svojstva sintetske morske vode prije i poslije elektrokoagulacije

t/h	T/°C		pH		Conductivity / mS cm^{-1}		TDS/g l^{-1}		Salinity / ppt	
without EC process										
0	21		8.36		45.3		22		29	
with EC process										
	before	after	before	after	before	after	before	after	before	after
0.5	21.0	21.5	8.13	6.39	45.3	44.4	22	21.9	29.2	28.6
1.0	20.1	21.5	8.36	5.95	45.3	44.8	22.5	22.4	29.0	28.9
1.5	21.3	22.8	8.48	6.18	44.7	44.5	22.4	22.5	28.5	28.9
2.0	22.3	23.4	8.22	6.08	45.3	45.8	22.9	22.9	29.5	29.6

electrode spacing of 2.5 cm and an applied current of 0.3 A. The duration of the EC process was varied between 0.5 and 2 h. The total removal efficiency of microplastics was determined for samples with and without EC processes (Table 3).

Table 3 – Relationship between MP removal efficiency and electrocoagulation time
Tablica 3 – Odnos između učinkovitosti uklanjanja MP-a i vremena elektrokoagulacije

	Microplastic particles		
t/h	m_{in} (mass of MP in solution at beginning of EC)/g	m_{end} (mass of MP in solution after EC)/g	R/%
without EC process			
0	0.5912	0.2468	58.25
with EC process			
0.5	0.6006	0.2273	62.15
1.0	0.6003	0.0952	84.14
1.5	0.6006	0.1452	75.82
2.0	0.6002	0.1373	77.12

The dissolution of anodes, the formation of hydrogen (H_2) and oxygen (O_2) bubbles, and the development of chemical reactions during the EC process positively influence the total removal efficiency of microplastics from synthetic seawater.[28,29] The total removal efficiency without the application of EC was 58.25 %, while it increased to 62.5 %, 84.14 %, 75.82 %, and 77.12 % with the application of EC and increasing process duration. The highest total removal efficiency of microplastics (84.14 %) was observed after 1 h of the EC process at pH 5.95. After 1 h, the removal efficiency decreased, likely due to changes in the pH of the synthetic seawater and the formation of deposits on the cathode. The deposits on the cathode may inhibit the formation of OH^- ions, which are essential for floc formation and the subsequent removal of microplastics. In addition, during the EC process, the concentration of released gases probably varied, because mixing and increased temperature can cause evaporation, contributing to an increase in pH and a reduction in total removal efficiency. The total removal efficiency of the microparticles remained high (75.82 % and 77.12 %) after 1 h of EC at pH values of 6.18 and 6.08, respectively. This is consistent with previous reports indicating that lower pH values (5.5–7.5) favour the formation and activity of aluminium hydroxides, which play a crucial role in coagulation and adsorption processes.[25]

To better understand the mechanism of the EC process, the consumption of anode material and the mass of collected sludge (Fig. 5) were measured during the experiment. As shown in Table 4, the consumption of anode material increased with EC duration and was independent of pH. Similarly, sludge mass increased with the duration of the EC process, regardless of pH. It should be noted that the sludge contained microplastic particles, aluminium hydroxide flocs, and probably all components of the synthetic seawater, such as magnesium and calcium salts, which precipitate during the process.

Table 4 – Relationship between anode material consumption and sludge mass under constant process conditions as a function of electrocoagulation time
Tablica 4 – Odnos između potrošnje anodnog materijala i mase mulja pri konstantnim uvjetima procesa kao funkcija vremena elektrokoagulacije

t/h	pH after EC process	m_{sl} (mass of sludge with MP after EC process)/g	Anode consumption /g
without EC process			
0	8.36	0	0
with EC process			
0.5	6.39	0.0652	0.8014
1.0	5.95	0.1424	1.5744
1.5	6.18	0.2120	2.0741
2.0	6.08	0.2546	2.4139

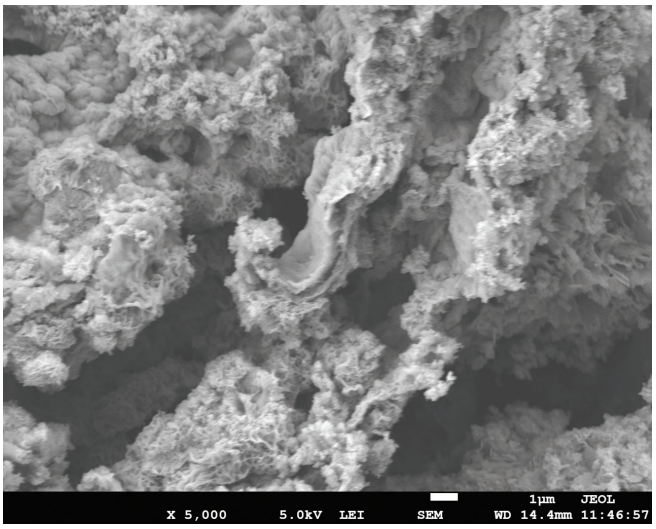

Fig. 5 – SEM image of the sludge formed after one hour of electrocoagulation
Slika 5 – SEM slika mulja koji je nastao nakon jednog sata elektrokoagulacije

The anode surface, after a shorter EC process (Fig. 6a), exhibited small, localised depressions, primarily within the grains, indicating the initial stage of corrosion with mild, localised dissolution.

After prolonged EC processing (Fig. 6b), the depressions become larger, and linear cracks and indentations appeared along the grain boundaries, characteristic of intergranular corrosion. In conclusion, besides localised corrosion due to anode dissolution, the surface features clearly indicated the presence of intergranular corrosion, explaining the increased anode dissolution over time and the availability of Al^{3+} ions for floc formation. Therefore, these aluminium-based anodes (AA6063) are suitable as sacrificial electrodes for the EC process in synthetic seawater.

4 Conclusion

The EC process is suitable for removing microplastic particles from synthetic seawater using aluminium-based anodes (AA6063). As a result of the chemical reactions and the composition of the synthetic seawater, the pH values decreased during the EC process from 8.36, 8.13, 8.36, 8.48, 8.22 to 6.39, 5.95, 6.18, 6.08, corresponding to the pH range in which aluminium hydroxides form and remain active. The total removal efficiency of microplastics in the EC process increased with process duration, reaching 62.5 %, 84.14 %, 75.82 % and 77.12 % for periods of 0.5 h, 1 h, 1.5 h, and 2 h, respectively. Optimal conditions were reached after one hour, when the MP removal efficiency reached 84 % at a pH of 5.95 at the end of process, with constant stirring at 250 rpm, room temperature of 21 ± 1 °C, a fixed electrode spacing of 2.5 cm, and an applied current of 0.3 A. The results demonstrate that the EC process can be considered an effective and practical method for removing microplastics from seawater, achieving high efficiency without the addition of chemicals. The EC process is simple to implement, easily scalable, and can be integrated into existing saltwater treatment plants. To further improve the removal efficiency of microplastics from seawater, future research should focus on reducing cathodic sediment deposition during the EC process and exploring recyclable materials for electrode fabrication.

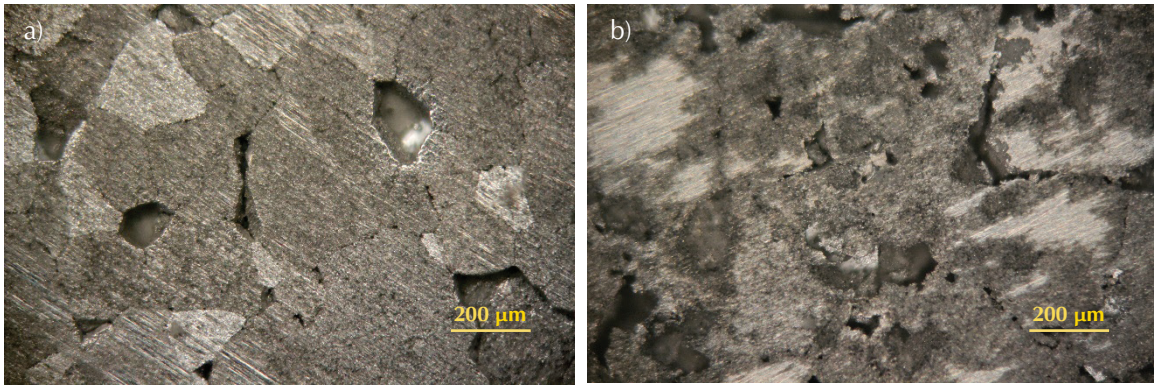

Fig. 6 – Optical microscope images of the anode surfaces a) after 1 h, and b) after 2 h of electrocoagulation at 100× magnification
Slika 6 – Slike površina anoda dobivene optičkim mikroskopom nakon 1 h (a) i 2 h (b) elektrokoagulacije pri povećanju 100×

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List of abbreviations and symbols
Popis kratica i simbola

XRF – X-ray fluorescence
– rendgenska fluorescencija

SEM – scanning electron microscopy
– pretražna skenirajuća mikroskopija

EDS – energy dispersive spectroscopy
– energetska disperzivna rendgenska spektroskopija

PE – polyethylene
– polietilen

PP – polypropylene
– polipropilen

PVC – polyvinyl chloride
– poli(vinil-klorid)

PS – polystyrene
– polistiren

PET – polyethylene terephthalate
– polietilentereftalat

EC – electrocoagulation
– elektrokoagulacija

MP – microplastic
– mikroplastika

TDS – total dissolved solids
– ukupne otopljene tvari

R – total removal efficiency
– ukupna učinkovitost uklanjanja

m_{in} – mass of MP in solution at beginning of EC
– masa mikroplastike u otopini na početku elektrokoagulacije

m_{end} – mass of MP in solution after EC
– masa mikroplastike u otopini na kraju elektrokoagulacije

m_{sl} – mass of sludge with MP after EC process
– masa mikroplastike u mulju na kraju elektrokoagulacije

t – time
– vrijeme

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SAŽETAK

Pruža li elektrokoagulacija učinkovito rješenje za uklanjanje mikroplastike iz sintetičke morske vode?

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Mikroplastika (< 5 mm) široko je prisutna u morskoj vodi zbog opsežne upotrebe plastike i predstavlja ozbiljan rizik za morske ekosustave. Elektrokoagulacija se ističe kao učinkovita metoda uklanjanja, pri čemu na uspješnost utječu svojstva čestica i operativni parametri. U ovoj studiji elektrokoagulacija je primijenjena za uklanjanje mikroplastike svjetlucavog tipa iz sintetičke morske vode. Veličina čestica određena je optičkim mikroskopom, a sastav morske vode karakteriziran je XRF analizom. Učinkovitost uklanjanja procjenjivana je primjenom aluminijskih elektroda (AA6063), uz razmak od 2,5 cm, konstantnu struju od 0,3 A, pH vrijednosti 5,5–7,5 i trajanje tretmana 15–120 min. Učinkovitost uklanjanja rasla je s trajanjem postupka te je iznosila 62,5 %, 84,14 %, 75,82 % i 77,12 % nakon 0,5 h, 1 h, 1,5 h i 2 h. Optimalni uvjeti postignuti su nakon jednog sata, kad je pri pH 5,95 i salinitetu 28,9 ppt. zabilježena maksimalna učinkovitost od 84 %. Dobiveni rezultati potvrđuju potencijal elektrokemijske koagulacije te pridonose boljem razumijevanju mehanizama uklanjanja mikroplastike iz sintetske morske vode.

Ključne riječi
Mikroplastika, elektrokaogulacija, aluminjska elektroda, sintetička morska voda

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