Contardi et al. loaded ciprofloxacin into poly(vinyl pyrrolidone) nanofiber by using acetic acid co-solvent in water. The antibacterial activity of the nanofiber mats was significant on *E. coli* and *B. subtilis* bacteria. In vivo studies on full-thickness excisional skin on mice model revealed wound resorption properties. The wound exudate absorption of the nanofiber mats was influenced by the concentration of the acetic acid concentrations [69]. Galkina et al. prepared cellulose nanofibers grafted with titania nanoparticles and loaded with two antibiotics, tetracycline and phosphomycin. The drug release was sustained and controlled. The nanofiber was effective against *S. aureus* and *E. coli* strain of bacteria in vitro. The nanofibers were stable under UV irradiation which was influenced by the presence of the loaded nanoparticles [104]. Xu et al. incorporation tetracycline hydrochloride into PEG-PLA nanofibrous scaffold. The nanofibrous membrane displayed sustained drug release for 6 days. It was effective against *S. aureus*. The good mechanical barriers, biodegradable nature and sustained delivery of the loaded antibiotics the nanofiber is useful for the treatment of malignant wounds and ulcers [105]. Shi et al. prepared polycaprolactone/gelatin nanofibers loaded with trimethoxysilylpropyl octadecyldimethyl ammonium chloride as wound dressing. The formulated nanofiber membranes exhibited bacteriostatic activity on *S. aureus* and *P. aeruginosa* bacteria [106]. Tohidi et al. loaded halloysite nanotubes with amoxicillin followed by incorporation into poly(lactic-*co*-glycolic acid) solution which was electrospun with chitosan nanofibers. The incorporation of the nanotubes did not change the morphology of the nanofibers but increased the diameter. The mechanical properties of the nanofiber were improved which was characterized by a high modulus. The drug release was controlled release [107]. Yu et al. prepared a natural sodium montmorillonite (Na-MMT) modified by cetyl trimethyl ammonium bromide (CTAB) as a carrier for amoxicillin. The drug-loaded organic montmorillonite was incorporated into poly(ester-urethane) urea (PEUU) and gelatin hybrid nanofibers by electrospinning. The sustained drug release property of the nanofiber influenced their antibacterial activity [108]. Safdari et al. loaded ceftazidime into silk fibroin/gelatin nanofibers. The average diameter of drug-loaded nanofiber was 276.55 nm. Drug release from the nanofiber was over a period of 6 h with good antibacterial effect suitable for the prevention of infections and postsurgical adhesions [109].

Zheng et al. prepared nano-hydroxyapatite particles loaded with amoxicillin followed by dispersion into poly(lactic-*co*-glycolic acid) solution to form electrospun hybrid nanofibers. The nanofibers displayed good cytocompatibility, sustained drug release profile and good antibacterial activity against *S. aureus* [110]. Ruckh et al. prepared poly(caprolactone) nanofiber loaded with rifampicin. The mean fiber diameters were 557 nm for the drug-free nanofiber, 402 nm for 10% drug-loaded nanofiber, and 665 nm for 20% drug loaded nanofiber. The drug release was a short-burst release in the first hour followed by a 7 h zero-order release. The drug-loaded nanofiber inhibited bacterial growth and prevented biofilm formation within the first 6 h [111]. Liu et al. loaded piperacillin/tazobactam into poly(ethylene teraphthalate) nanofiber by ionic interaction between anionic piperacillin/tazobactam and the cationic nanofibers. There was no loss in the features of the nanofiber. The drug-loaded nanofibers displayed a high drug loading efficiency and sustained drug release. The antimicrobial activity of the drug-loaded nanofibers was potent against Gram-positive and Gram-negative strains of bacteria. In vivo studies on *P. aeruginosa*-infected mouse skin wound showed that the drug-loaded nanofibers were more effective when compared with the free drug which was characterized by a significant lower *P. aeruginosa* counts at the wound sites [112].

3.7. Membranes

Polymer-based membranes have been used for the management of acute and chronic wounds (Table 5). These membranes are loaded with antibacterial agents. Most of them are prepared from natural polymers. Some have a porous structure beneficial for the uptake of wound exudates and an occlusive layer to impede microbial invasion and excessive loss of water [117]. Kimna et al. loaded gentamicin into zein-based bilayer membranes fabricated for the treatment of acute skin infections. The membranes displayed structural feature similar to the skin tissue layers with characteristic fiber diameter in the range of 350–425 nm and thickness in the range of 311–361 μm. The mechanical properties of the membrane were compatible with the skin. Furthermore the membranes displayed significant antimicrobial activity against *S. aureus* and *E. coli*. The drug release profile of the membrane was sustained with a cumulative drug release of 94%. No significant cytotoxic effect of the membrane was observed. The membrane enhanced cell growth mimicking the multilayer skin tissue revealing their potential application for skin tissue regeneration [118].

Aragon et al. prepared asymmetric membrane characterized with interconnected pores composed of a top layer that impedes rapid loss of moisture that can