Aim of this work was to evaluate the optimum conditions for functionalisation of polyethersulfone (PES) ultrafiltration (UF) membranes, as such modified membranes have been already viewed as very promising "new generation" low-fouling materials [1]. Anti-fouling composite membranes were prepared via photo-initiated "grafting-from" of the hydrophilic monomer poly(ethylene glycol) methacrylate (PEGMA) on commercial PES UF membranes with wide range of nominal molecular weight cut-off (MWCO). A fine adjustment of the sieving properties of the modified membranes was achieved by addition of suited crosslinker monomers in appropriate ratio to the reaction mixture. In this study, two crosslinkers were used: N,N'-methylene bisacrylamide (MBAA) and pentaerythritol triallyl ether (PETAE). Systematic variations of UV intensity and UV irradiation dose in combination with different monomer mixtures were performed in order to examine the effect of UV irradiation and crosslinker type and amount on the fouling and selectivity behaviour of the composite membranes. Therefore, a comprehensive study of the membrane properties via contact angle (CA), zeta potential (ZP), water permeability, selectivity/rejection and microscopic measurements was performed.

The results showed that at same UV irradiation dose, increasing the UV irradiation intensity led to increased degree of grafting (DG), higher water permeability but also increased MWCO. By this means, at higher UV intensity, the synthesis of more hydrogel on the membrane surface did not lead to lower membrane cut-off due to the more aggressive conditions at relatively high UV intensity leading to more open membrane structure. The type and amount of the used crosslinkers had an impact on the membrane performance as well. Crosslinking with MBAA led to lower flux and cut-off values; by increasing the amount of MBAA this effect was amplified. In contrast, the crosslinking with PETAE increased the flux and cut-off. Applying the optimised functionalisation conditions made it possible to prepare membranes with similar water flux and sieving properties to virgin membranes but with better fouling resistance.

Furthermore, the fouling behaviour and principles, and the membrane performance of virgin and modified membranes were evaluated during filtration experiments with proteins (myoglobin, bovine serum albumin, γ-globulin, fibrinogen and thyroglobulin), humic substances and polyphenolics as well as during cleaning and long term stability tests.

Membrane properties (membrane chemistry, morphology and charge), solution properties (solutes nature, size, concentration and charge) as well as operating parameters (hydrodynamics and operation mode) had an impact on the membrane performance during filtration, since these parameters influence the membrane-solute and solute-solute interactions governing fouling. The modification with hydrogel layer increased the fouling resistance of the membranes. Modified membranes with similar water flux and cut-off to virgin membranes showed higher permeate fluxes and more stable rejection properties during filtration. After several cleaning steps, functionalised membranes showed more stable behaviour and better filtration performance.

The obtained results suggested that by adapting the membrane characteristics and operation conditions to the properties of the feed to be filtered, the performance of the desired process can be well controlled by minimising fouling effects.