A novel approach for blood purification: Mixed-matrix membranes combining diffusion and adsorption in one step

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1. Introduction

The prevalence of end-stage renal disease (ESRD) was ~535,000 in the USA in 2008. Of these patients, ~355,000 were treated with hemodialysis. Despite the high health care costs of dialysis treatment (over €50,000 per patient per year), hemodialysis is only partially successful in the treatment of patients with ESRD. Mortality (15–20% per year) and morbidity of these patients remain excessively high, whereas their quality of life is generally low [1]. This is reflected in the expected remaining life years, which are 25.0 years for the general US population, 15.7 for ESRD patients with a kidney transplant and 5.6 years for ESRD patients receiving dialysis treatment [2].

In the last three decades, sorbent technology has been applied in the treatment of severe intoxication and to increase the efficiency of hemodialysis, or replace it, and as a treatment for fulminating hepatic failure. In hemoperfusion (or plasma perfusion), blood (or plasma) is purified by extracorporeal passage through a column containing the adsorbent which can remove or neutralize the substance of interest. Hemoperfusion cannot fully substitute hemodialysis because it does not remove urea and excess fluid. Sorbents used in hemoperfusion help to remove uremic toxins; however, direct blood contact with the adsorbent often causes hemocompatibility issues, especially on the long term [3]. Activated carbon (AC) has a long record as a sorbent in blood purification in the case of intoxications, acute and chronic renal failure as well as liver failure [3–5]. Uncoated activated carbon is a strong adsorbent for uremic toxins [6] whereas polymeric coatings of activated carbon might...