# Surfaces effects of thin polymeric membranes for $CO_2$ capture and to reduce its emissions


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The emission of carbon dioxide ($CO_2$) is one of the serious environmental problems and has been recognized as the main contributor to global warming and climate change [1]. The Transnational Paris Agreement signed in 2016 set the goal for governments to limit the further emission of $CO_2$ into the atmosphere to reduce interference with Earth's climate system, which is essential for sustainable food production and economic development [2].

The emission of $CO_2$ can be reduced through several ways and its separation by polymeric membranes is considered one of the promising options for its capture. However, this technique suffers of a low throughput and the challenge is make selective layer very thin to achieve high flux [3]. Nanotechnology efforts are focused on reducing the thickness of the membrane to be as thin as possible (<50 nm). Nano constrain on selective layers can produce different macromolecular conformations and crystallization processes such that to obtain exceptional results in terms of permeance and selectivity. Unfortunately, these researches are still far from technology transfer because of low reliability.

We develop a high vacuum system to measure gas transport properties of polymeric membranes without artefacts [4]. Studies on $CO_2$ permeability of PDMS membranes with thickness ranging from 200 nm to 100 µm have revealed a thickness dependence of the gas flux on the thickness. This phenomenon is related to Non-Equilibrium Conditions (NEC) at the membrane surfaces and is valid for any couple of gas/polymer [5]. Considering this drawback, we have developed PDMS membranes with nano corrugated surfaces. The results show that for thicknesses such that NEC limits the gas flux, the roughness increases the permeance and have effects also on the selectivity [6]. This simple modification allows to enhance the gas throughput and it is cost effective because of its easily of fabrication.

[1] Stern N. Stern review on the economics of climate change. Cambridge: Cambridge University Press; 2006.

[2] Rogelj J, den Elzen M, Hohne N, et al. Paris agreement climate proposals need a boost to keep warming well below 2 °C. *Nature*, **534(7609)** (2016) 631–639.

[3] Roman Selyanchyn & Shigenori Fujikawa Membrane thinning for efficient CO2 capture, *Science and Technology of Advanced Materials*, **18:1**, (2017) 816-827

[4] Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting. ASTM International Designation: D1434-82 (Reapproved 2015)

[5] Firpo, G., Angeli, E., Repetto, L., Valbusa, U., Permeability thickness dependence of polydimethylsiloxane (PDMS) membranes, *Journal of Membrane Science*, **481**, (2015) 1-8.

[6] Firpo, G., Angeli E., Guida, P., Lo Savio R., Repetto, L., Valbusa, U., Gas permeation through rubbery polymer nano-corrugated membranes, *Scientific Reports* **8(1),** (2018)