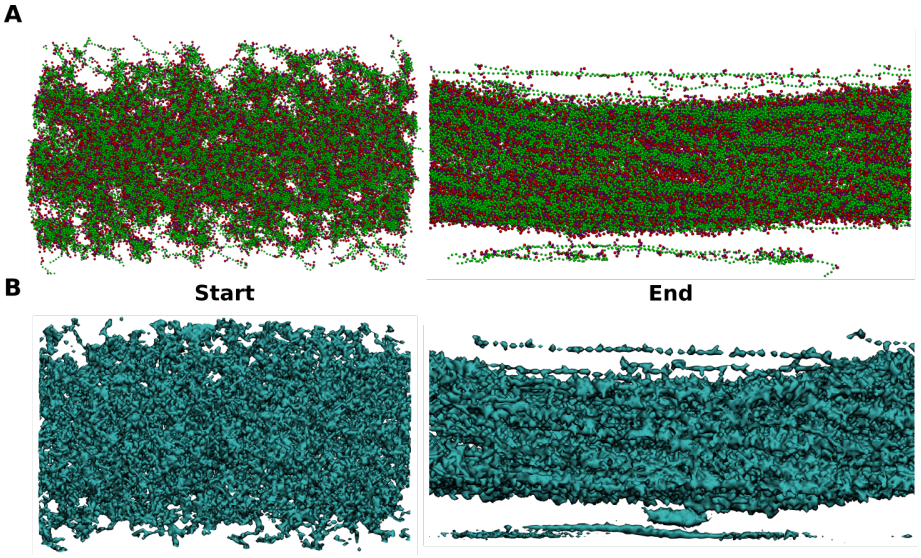
Nafion Concentration (wt %)	Chain Length (no. monomers)	Simulation Time (ns)	Repeats	Shear Rate (s^{-1})
5	20	400	3	$4x10^8$
	20	400	3	$4x10^7$
	20	400	3	$4x10^6$
	50	400	3	$4x10^8$
	50	400	3	$4x10^7$
	50	400	3	$4x10^6$
10	20	400	3	$4x10^8$
	20	400	3	$4x10^7$
	20	400	3	$4x10^6$
	50	400	3	$4x10^8$
	50	400	3	$4x10^7$
	50	400	3	$4x10^6$
16	20	400	3	$4x10^8$
	20	400	3	$4x10^7$
	20	400	3	$4x10^6$
	50	400	3	$4x10^8$
	50	400	3	$4x10^7$
	50	400	3	$4x10^6$
20	20	400	3	$4x10^8$
	20	400	3	$4x10^7$
	20	400	3	$4x10^6$
	50	400	3	$4x10^8$
	50	400	3	$4x10^7$
	50	400	3	$4x10^6$

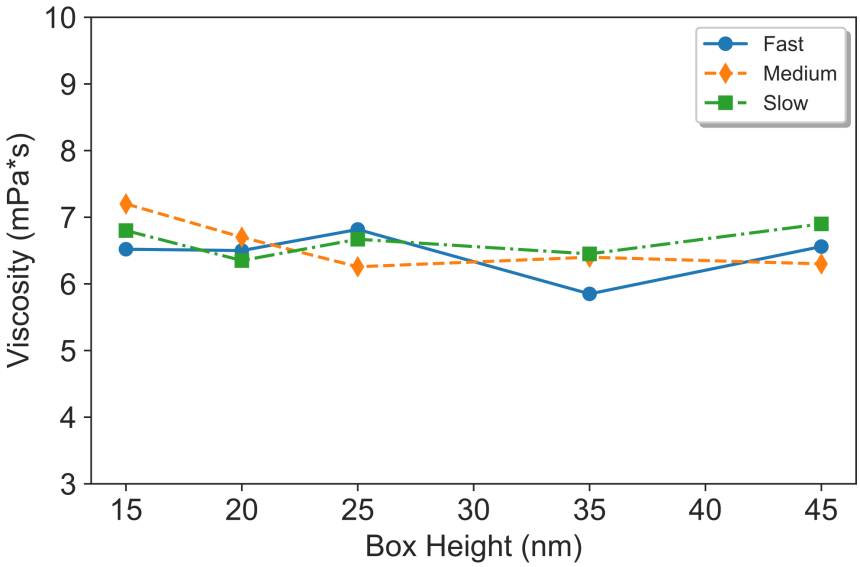
Supporting Table 1 – A summary of the shearing simulations run at different Nafion concentrations.

Shear Rate (s^{-1})	**Wall Distance d (nm)**	**Simulation Time (ns)**	**Repeats**
$4x10^8$	15	400	3
	20	400	3
	25	400	3
	35	400	3
	45	400	3
$4x10^7$	15	400	3
	20	400	3
	25	400	3
	35	400	3
	45	400	3
$4x10^6$	15	400	3
	20	400	3
	25	400	3
	35	400	3
	45	400	3

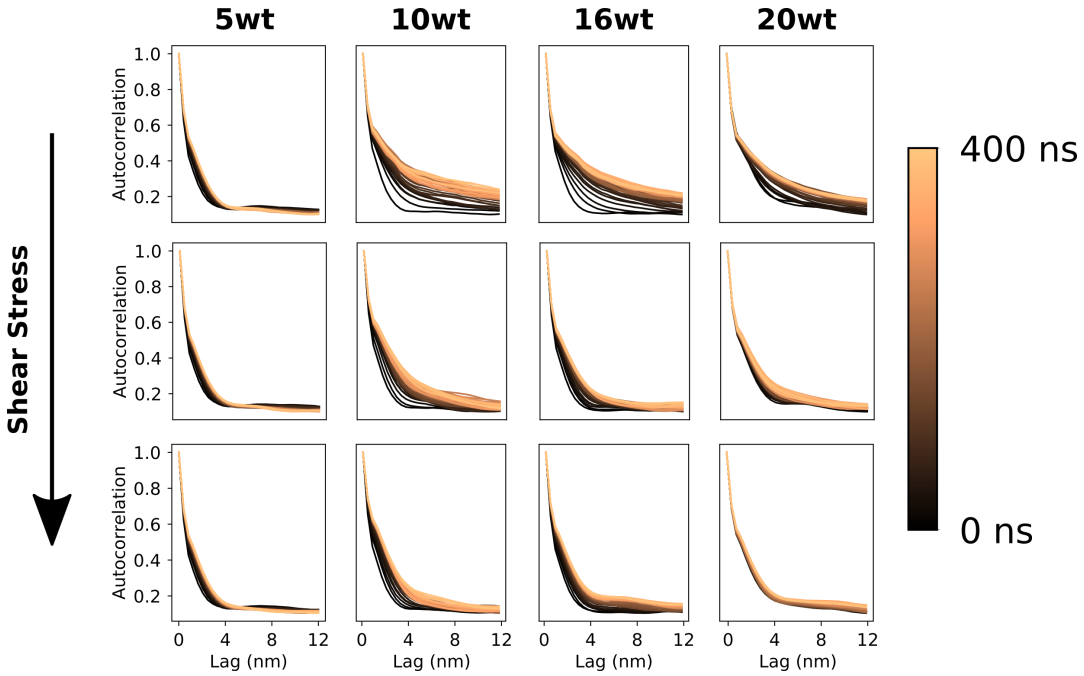
Supporting Table 2 – A summary of the shearing simulations run at different wall distances (d).



Supporting Figure 1 – (A) A snapshot of the Nafion chains (20 wt%) at the beginning and the end of the shearing simulation at a shearing rate of $4\text{x}10^{8}s^{-1}$ (B) and its corresponding density map calculated with GROmaρs.



Supporting Figure 2 – Viscosity of a 10 wt% Nafion solution sheared at a fast ($4x10^8 s^{-1}$), medium ($4x10^7 s^{-1}$) and slow ($4x10^6 s^{-1}$) rate and at different wall distances d (box height).



Supporting Figure 3 – The autocorrelation along the flow (X) axis of the density maps, for different shear rates and along the simulated time (0-400 ns at 10 ns intervals, color-coded from black to bronze), for 50-monomer Nafion chains. Top, middle and bottom graphs show results for the highest, intermediate, and lowest shear rate, respectively.