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Phase-resolved Body-force Determination of an AC-DBD Plasma Actuator in Laminar Flow MARC TOBIAS HEHNER, Karlsruhe Institute of Technology (KIT), GONCALO COUTINHO, Technical University of Lisbon, RICARDO PEREIRA, Delft University of Technology, NICOLAS BENARD, University of Poitiers, JOCHEN KRIEGSEIS, Karlsruhe Institute of Technology (KIT)
— In continuation of earlier efforts (Kriegseis et al., 2013, JPhysD, Benard et al., 2013, JPhysD, Pereira et al., 2014, JApplPhys, Dörr&Kloker, 2015, JPhysD) the present study revolves around the PIV-based characterisation of plasma-induced body-force fields in laminar boundary layers ($U_\infty \leq 30$ m/s). Both common approaches, Navier-Stokes equation (NSE) and vorticity equation (VE), are applied to the obtained phase-resolved velocity data (24 phases). The extracted forces are compared in terms of time-averaged and phase-resolved force distributions. Additional force-magnitude information is determined to evaluate the impact of the airflow on the actuator performance. The plasma actuator exerts a co-flow force (along mean flow) in a flat-plate laminar boundary-layer flow. The power consumption of the actuator was found constant for $U_\infty \leq 30$ m/s. Interestingly, the determined force from NSE changes significantly with increasing airflow velocity, whereas the calculated force from VE budgets a constant integral force magnitude. Consequently, the implied assumptions of either approach are revisited and limits of the formerly consider suitable simplifications – at least for quiescent air – are discussed on the basis of the obtained data.

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