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Turbine blade cooling using Coulomb repulsion ROBERT BREIDENTHAL, University of Washington, JOSEPH COLANNINO, JOHN DEES, DAVID GOODSON, IGOR KRICHTAFOVITCH, TRACY PREVO, ClearSign Combustion Corp. — Video photography and thermocouples reveal the effect of an electric field on the flow around a stationary, idealized turbine blade downstream of a combustor. The hot products of combustion naturally include positive ions. When the blade is an electrode and elevated to a positive potential, it tends to attract the free electrons and repel the positive ions. Due to their lower mass, the light electrons are rapidly swept toward the blade, while the positive ions are repelled. As they collide with the neutrals in the hot gas, the positive ions transfer their momentum so that a Coulomb body force is exerted on the hot gas. Cool, compressed air is injected out of the stationary blade near its leading edge to form a layer of film cooling. In contrast to the hot combustion products, the cool air is not ionized. At the interface between the hot gas and the cool air, the Coulomb repulsion force acts on the former but not the latter, analogous to gravity at a stratified interface. An effective Richardson number representing the ratio of potential to kinetic energy characterizes the topography of the interface. When the electric field is turned on, the repulsion of the hot gas from the idealized blade is evident in video recordings and thermocouple measurements.

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