Proceedings of 2004 ASME Turbo Expo:
Power for Land, Sea & Air
June 14-17, 2004 – Vienna, Austria

GT2004-53870

OPERATION OF A MESOSCOPIC GAS TURBINE SIMULATOR AT SPEEDS IN EXCESS OF 700,000 RPM ON FOIL BEARINGS

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ABSTRACT

A small mesoscopic gas turbine engine (MGTE) simulator was tested at speeds over 700,000 rpm. The MGTE was operated with specially designed miniature compliant foil journal and thrust air bearings. The operation of the simulator rotor and foil bearing system is a precursor to development of turbine powered micro aerial vehicles and mesoscopic power generators. The foil bearings use a new fabrication technology in which each bearing is split. This feature permits the use of these bearings in highly advanced engines where single piece ceramic rotors may be required. The simulator weighed 56 grams (including the 9 gram rotor) and included two non-aerodynamic wheels to simulate the compressor and turbine wheels. Each compliant foil journal bearing had a diameter of 6 mm and was located equidistant from each end of the rotor. Experimental work included operation of the simulator at speeds above 700,000 rpm and at several different orientations including having the spin axis vertical. Results of the rotor bearing system dynamics are presented along with experimentally measured natural frequencies at many operating speeds. Good correlation between measurement and analysis is observed indicating the scalability of the analysis tools and hardware used. The rotor was very stable and well controlled throughout all testing conducted. Based on this successful testing it is expected that the goal of operating the rotor at speeds exceeding 1 million rpm will be achieved.

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