



Extreme Temperature Motors and Drivetrains for Venus Exploration A Breakthrough Development

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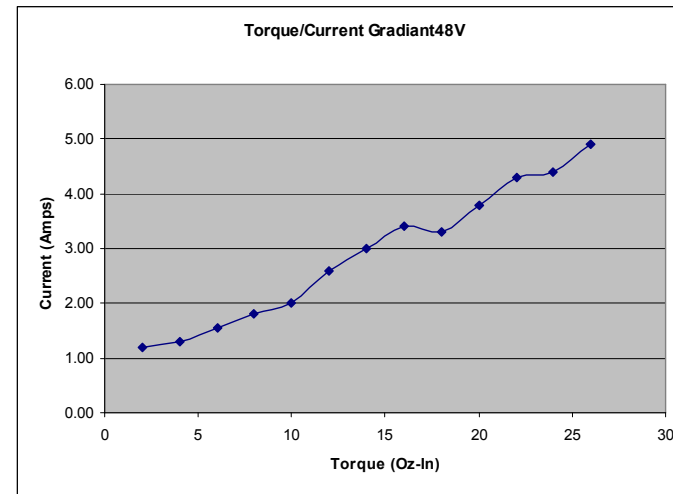
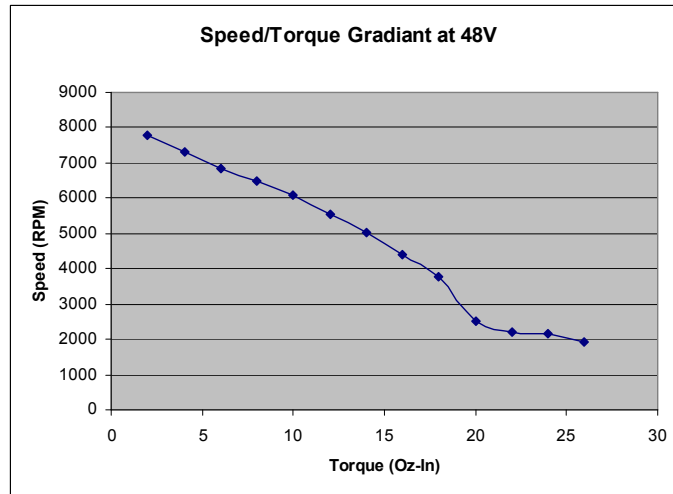
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High Temperature Motor Breakthrough



- **Two types of motor have been developed, all materials and components are rated above 460°C:**
 - Switched Reluctance Motor (currently in SBIR Phase II)
 - The prototype SRM has been operated non-continuously for over 20 hours at 460°C with CO₂ flow and it is still functioning properly. A high temperature drill actuated by the SR motor is under integration and will be tested at 460C.
 - DC Brushless Motor with resolver (awarded Phase II in October, 2007)
 - continue development of BLDC motor along with high temperature sample acquisition scoop and high temperature joint.
- **Goal of development is to achieve a comprehensive TRL 6 with both efforts (extensive testing at Venus temperature and pressure). Switched Reluctance (SR) Motor and the Brushless DC Motor are expected to be mission ready before next New Frontiers AO release.**
- **The SR and BLDC motors are no longer expected to limit the life of Venus surface operation; with accompanying high temperature bearing development, surface operations are limited only by available power.**
- **Scalable high temperature motor and bearing developments allow for creation of long lasting sample acquisition systems, booms, robot arms and even mobility systems. This allows for major restructuring of traditional Venus surface exploration scenarios.**

SR Motor Data at 460C*



Motor Characteristics Comparison of Existing Maxon RE-25 to Current SRM Prototype*

Characteristics	Units	Maxon RE-25	SRM Prototype
		Range at 25°C	Range at 460°C
Applied Voltage	V	4.5 - 48	20 - 48
Maximum Speed	Rpm	5500	7500
No-Load Speed	rpm	4790 - 5500	7000-7500
No-Load Current	mA	7 - 80	1000-1200
Stall torque	mNm	119 - 144	200 - 250

*All test data are from motor test controlled by a custom controller which we are still optimizing.

A high temperature motor controller will be developed if the submitted proposal is awarded through NASA SBIR program.

The Maxon RE-25 motor has been used to actuate various prototype and flight system drills, robotic arms and other mechanism actuators by NASA and Honeybee Robotics. A flight version of the Maxon RE-25 is the largest motor used on the Mars Exploration Rover mission.