

### Company Data

#### CONTACTS

**DANIELE PANFIGLIO**  
Managing Director

#### COMPANY FOUNDED

2006

#### NUMBER OF EMPLOYEES

16

#### PARENT COMPANY

**COMSOL AB**  
Tegnérgatan 23  
SE-111 40 Stockholm – Sweden

#### SISTER COMPANIES

**COMSOL France SAS**  
Avenue Doyen Louis Weil 10  
Grenoble FR-38000 – France

**Cmsol Multiphysics GmbH**  
Robert-Gernhardt-Platz 1  
Göttingen 37073 – Germany

**COMSOL BV**  
Röntgenlaan 37  
Zoetermeer 2719 DX – The Netherlands

**COMSOL Multiphysics GmbH**  
Technoparkstr. 1  
Zürich 8005– Switzerland

**COMSOL, Inc.**  
District Avenue 100  
Burlington MA 01803 – USA

**COMSOL Ltd.**  
Park House - Castle Park  
Cambridge CB3 0DU – United Kingdom

**COMSOL LLC**  
Bolshaya Sadovaya 10  
Moscow 123001 – Russia

**COMSOL Ltda**  
Av. Cândido de Abreu, 776, Cj 1601  
Curitiba CEP – Brazil

**COMSOL Co., Ltd.**  
Lujiazui Financial Services Plaza 2D  
Dongfang Road. 1217,  
Pudong New District, Shanghai 200127  
China

#### PLANNED EXHIBITIONS

**Battery World 2020**  
Piacenza, Italy - 6/7 May 20200

**MECSPE**  
Parma, Italy - 18/20 June 2020

**Coiltech**  
Pordenone, Italy - 23/24 September 2020

### COMSOL® - IMPROVING BATTERIES AND FUEL CELLS PERFORMANCE WITH SIMULATION

COMSOL is a global provider of simulation software for product design and research. Its COMSOL Multiphysics® product is an integrated software environment for creating physics-based models and simulation apps. The company includes 19 offices worldwide and a network of distributors.

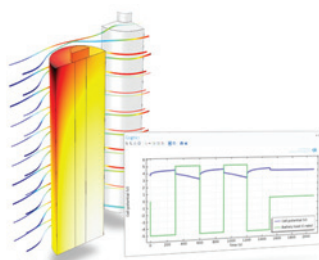
Batteries and fuel cells are being asked to perform in harsher environments, with greater energy densities or power efficiencies and over longer lifetimes. The increased demand and the pressure for improving battery performance, especially for meeting new environmental international goals, have intensified the need for mathematical modeling.

Simulation tools allow the analysis of almost all design parameters and conditions cutting the cost of extensive experimental campaigns. These parametrizations include response to change in geometrical dimension, in electrode materials, and in electrolyte composition. Performance prediction can be done modeling several charge-discharge cycles including various mechanism of

losses. Electrochemical impedance spectroscopy (EIS) can also be performed to monitor the state of health (SOH) of batteries. Losses and others phenomena, as activation overpotential, produce heat and thermal management of battery packs, including cooling mechanism and possible thermal runaway, must be assessed, starting with simulation, for guaranteeing safety. Aging processes can also be accelerated by high temperatures.

Examples of systems that may be studied include: lead-acid batteries, lithium-ion batteries, nickel metal-hydride batteries, solid oxide fuel cells (SOFCs), direct-methanol fuel cells (DMFCs), and proton exchange membrane fuel cells (PEMFCs).

The Batteries & Fuel Cells Module, an add-on product to COMSOL Multiphysics® software, is the only simulation tool that can be used for modeling all types of fuel cells and batteries, with the most robust features for simulating all varieties of electrochemical behaviors. It implements the workhorse of fidelity models, the Newman model, validated and extended to include, for example, all electrode\electrolyte couples, the growth of solid electrolyte interface and short circuits. Simulation of charge and chemicals transport can be naturally coupled to current conduction, fluid flow, heat transfer, and any other phenomena that can be modeled within COMSOL. The module also includes lumped battery interfaces for quick performance assessment within a range of conditions and either alone or combined with functionalities included in other modules of COMSOL product suite allows for state of the art research work with heterogenous modeling of all relevant phenomena.



#### Range of products

- SIMULATION SOFTWARE FOR PRODUCT DESIGN AND RESEARCH
- BATTERIES AND FUEL CELLS MODELING
- COMSOL MULTIPHYSICS® SOFTWARE



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