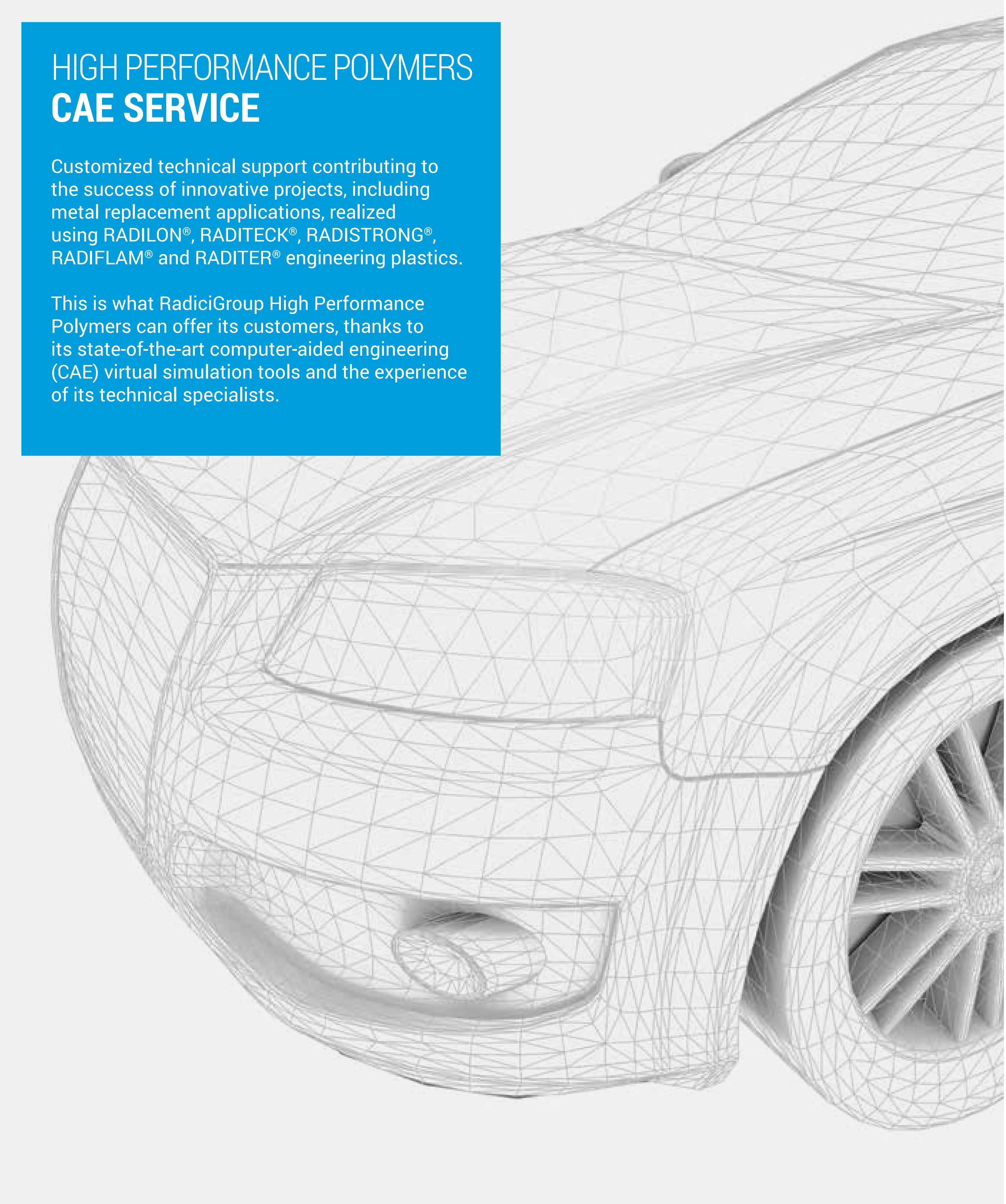
HIGH PERFORMANCE POLYMERS
CAE SERVICE

Customized technical support contributing to the success of innovative projects, including metal replacement applications, realized using RADILON®, RADITECK®, RADISTRONG®, RADIFLAM® and RADITER® engineering plastics.

This is what RadiciGroup High Performance Polymers can offer its customers, thanks to its state-of-the-art computer-aided engineering (CAE) virtual simulation tools and the experience of its technical specialists.



Nowadays, a well-equipped set of CAE tools is considered an essential support for the development of a component.

Designing with plastics requires reliable tools for the numerical simulation of the **injection molding process,** as well as advanced structural FEM codes for **static and dynamic structural analysis** to enable the optimization of component geometry and performance.

Moreover, advanced **material modelling** solutions can make accurate assessments using an **integrated simulation approach,** by coupling the process-induced properties, such as **fiber orientation** and **weld lines,** with the expected mechanical behaviour.

CAE Service

RadiciGroup High Performance Polymers CAE Service makes all these advanced technologies available, allowing our customers and partners to boost their development process, while simultaneously achieving higher goals in lightweighting, safety and performance.

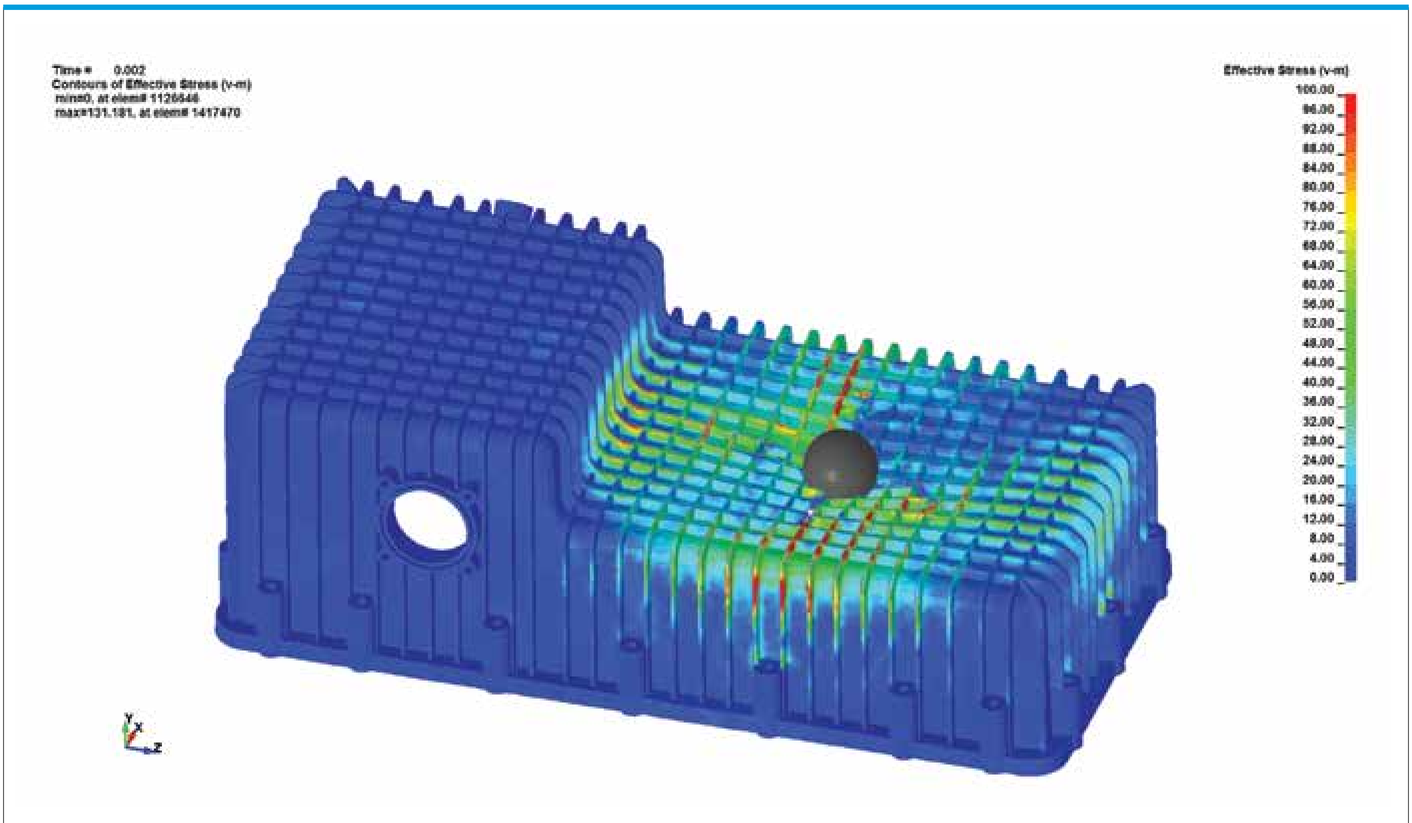


Figure 1 | Dynamic impact simulation of an oil pan made of glass-fiber-reinforced Radilon® PA6.6: stress analysis.

Why use CAE?

There are many benefits from the use of CAE tools throughout the various phases of project development:

- Minimizing trial and error and the use of physical prototypes.
- Assessing the feasibility of a proposal starting from the early stages of design.
- Detecting and correcting any problems in the virtual environment, when the cost of making changes is still relatively low.
- Optimizing component geometry through maximum leverage of material performance.
- Exploring and comparing alternative solutions to choose the best option.
- Troubleshooting unexpected issues during the prototype phase.
- Keeping costs under control and saving time to market.

Injection molding process simulation

Will the part be correctly filled and packed using the chosen material?

What is the best gate position to optimize melt fill and minimize warpage?

Can a multiple-cavity part be molded with a 150-ton machine? What is the required fill pressure?

Are there any potential molding defects, such as air bubbles or weld lines, which could affect the aesthetic or structural characteristics of the part?

Will the component dimensions fall within the prescribed design tolerances?

These are just some of the questions that a project engineer must deal with. By using **process simulation,** RadiciGroup High Performance Polymers CAE Service can readily find the answers during the early project development phase.

Numerical simulation of the complex physical and fluid dynamic process taking place during injection molding – including gas or water-assisted injection molding (GAIM/WAIM), over-injection and co-injection – can help engineers make decisions regarding the design of the part and the mold.

The output of a simulation process supplies a wealth of data on mold **filling,** material **packing and cooling,** predicting **critical features** of the molded part, e.g., glass fiber orientation, sink marks, weld lines and post-molding warpage. With the aid of appropriate mapping tools, some of these fields can be transferred to non-linear structural analysis software to carry out an advanced integrated analysis.

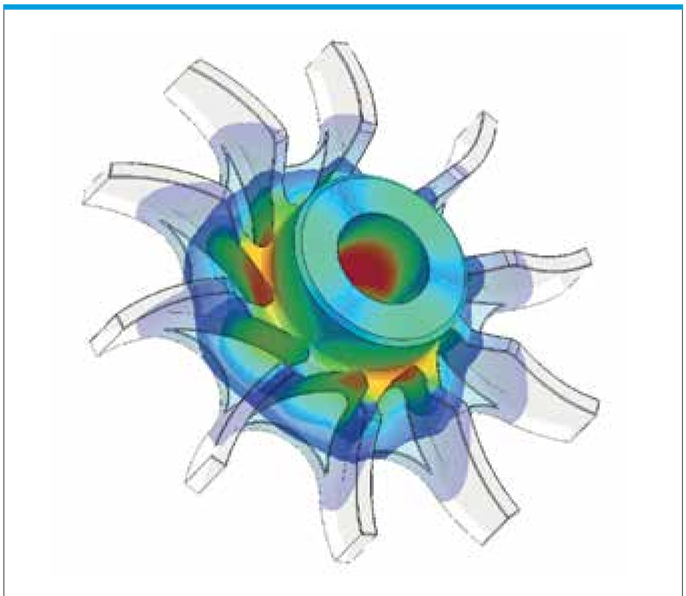


Figure 2 | Fill Pattern – simulation of mold cavity filling for a pump impeller.

Figure 3 | Warpage prediction for a thermoplastic gear (magnified scale).

Static and dynamic structural analysis

Will the component withstand operating loads and conditions without any damage or breakage?

Will the expected deformation of the part under load remain within acceptable functional limits?

Are the natural vibration modes and frequencies of the designed part compatible with specifications?

Will the component pass an impact test at a prescribed energy level without breaking or getting damaged?

Are long-term material resistance phenomena like creep and fatigue of concern?

The increasing use of engineering specialty polymers for demanding technical applications, including **metal replacement** parts, makes an accurate structural assessment indispensable. With the help of specific CAE tools, the mechanical behaviour of components can be predicted, which means knowing in advance whether the **design loads** are safely below the failure limit.

Furthermore, it is possible to perform **design optimizations** that would otherwise require the building of prototypes, with a considerable outlay of time and financial resources. For this purpose, RadiciGroup High Performance Polymers CAE Service is able to provide its customers with **static non-linear** structural studies on parts and assemblies, as well as **dynamic** analyses involving phenomena related to **impact** and **vibrations,** based on state-of-the-art FEM commercial codes.

In order to accurately predict component behaviour, an in-depth **characterization** of the **material** is needed, comprising not only its basic mechanical properties (modulus of elasticity, load at break, etc.) but also its thermo-mechanical behaviour, and, specifically for dynamic analysis, its strain-rate dependency. Long-term effects, such as creep, fatigue and heat ageing, should also be considered when relevant for the application.

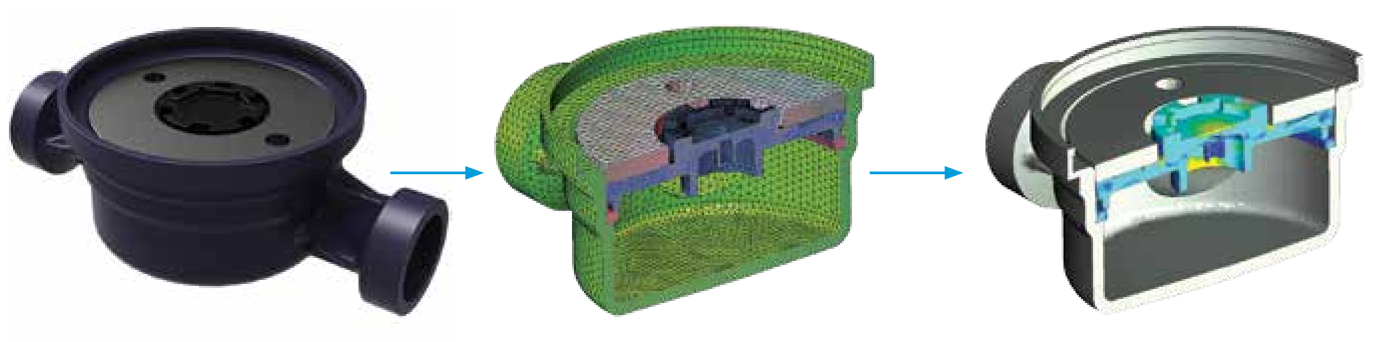


Figure 4 | Structural analysis of a water meter diaphragm made of glass-fiber-reinforced Radilon® PA6.12, from load and constraint definition to tension state prediction.

Figure 5 | Glass-fiber orientation in a part depends on how the cavity is filled during molding. A shell-core structure is typically obtained when thin plates are injection molded, as can be seen in the microtomographic scan image on the right.

Integrated simulation approach

Reinforced engineering plastics exhibit a complex physical and mechanical behaviour characterized by non-linearity, even at low loads, and a tight dependency on a variety of process parameters; in particular, the **orientation** of reinforcement, **glass fiber** for instance, has a great influence. The commonly used approach treating such materials as macroscopically homogeneous and isotropic can be acceptable as a first approximation in early stages, but, for more accurate predictions, it may not be enough.

To perform more reliable studies and optimizations, particularly for innovative metal replacement applications, RadiciGroup CAE Service offers an **integrated approach** – a solution using structural calculus to take into account the material properties induced by the process, such as anisotropy caused by reinforcement orientation, weld line weakening effect, warpage, and so on. This analysis is achieved by specialized multi-scale material modelling software and very thorough laboratory testing of RadiciGroup products, specifically aimed at investigating the mechanical properties in all directions.

An integrated approach, if correctly applied, allows the designer to obtain much better predictions and reduces the need to introduce arbitrary safety coefficients.

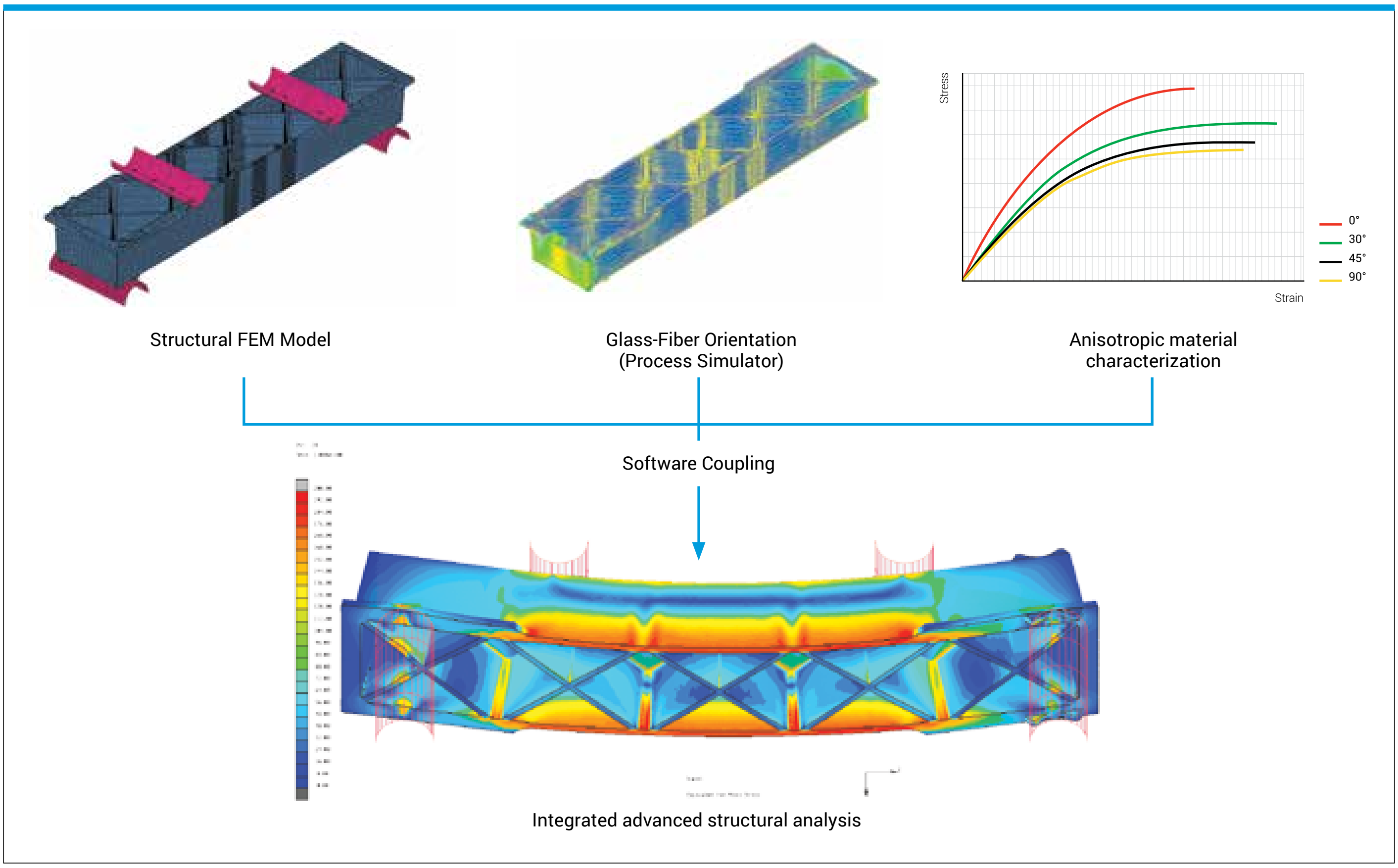


Figure 6 | Scheme of an Integrated Structural Analysis: simulation of a four points bending test on a ribbed beam. The coupling software transfers the local property of the material induced by the process onto the structural mesh of the component.

RadiciGroup High Performance Polymers CAE Service: a development partner

RadiciGroup High Performance Polymers, through its Marketing and Applications Development team, can provide full support during all phases of the design process, including:

- **Concept** phase proposals and consulting.
- Translation of **functional requests** into material properties.
- **Material selection** based on RadiciGroup High Performance Polymers' outstanding product range.
- Support and consulting on comparative **cost analysis.**
- Support and consulting during the **product re-design** phase.
- **CAE analysis.**
- **Environmental impact** and **Life Cycle Assessment** analysis: full, certified support.
- **Technical service** support during prototyping, molding trials and part testing.

HIGH PERFORMANCE POLYMERS

Global Presence

RADICI NOVACIPS SpA
Via Bedeschi, 20 – 24040 Chignolo d'Isola (BG) – IT
Ph. +39 035 4991311 – Fax +39 035 994386
e-mail: italia.plastics@radicigroup.com

RADICI NOVACIPS SpA
Via Provinciale, 1331 – 24020 Villa d'Ogna (BG) – IT
Ph. +39 0346 22453 – Fax +39 0346 23730
e-mail: italia.plastics@radicigroup.com

RADICI PLASTICS GmbH
Glockengiesserwall 2 – 20095 Hamburg – DE
Ph. +49 40 3095410 – Fax +49 40 30954199
e-mail: rplde.info@radicigroup.com

RADICI PLASTICS IBERICA SL
Avda. Josep Tarradellas, 130 5º1ª
08029 Barcelona – ES
Ph. +34 93 5416500 – Fax +34 93 4943326
e-mail: iberica.plastics@radicigroup.com

RADICI PLASTICS UK Ltd.
7 Langham House - 148 Westgate
Wakefield, England WF2 9SR - UK
Ph. +44 (0)20 7431 4554
e-mail: uk.plastics@radicigroup.com

RADICI PLASTICS LTDA
Rua Giuseppe Marchiori, 497
CEP 18147-970 Araçariguama – São Paulo – BR
Ph. +55 11 4136 6500
e-mail: brasil.plastics@radicigroup.com

RADICI PLASTICS FRANCE SA
65, Rue du Dauphiné – 69800 St. Priest – FR
Ph. +33 4 72782090 – Fax +33 4 72782089
e-mail: france.plastics@radicigroup.com

RADICI PLASTICS USA Inc.
960 Seville Road, Wadsworth, OH 44281 – USA
Ph. +1 330 3367611 – Fax +1 330 3355029
e-mail: usa.plastics@radicigroup.com

RADICI PLASTICS (Suzhou) CO., LTD.
No. 49 Ping Sheng Road, SIP
215126 Suzhou, Jiangsu Province – PR China
Ph. +86 512 62952290 – Fax +86 512 62952291
e-mail: china.plastics@radicigroup.com

RADICI PLASTICS INDIA PVT. LTD.
501, DLF Tower, Shivaji Marg
New Delhi - 110015 – IN
Ph. +91 11 41638 170
e-mail: info.plastics@radicigroup.com

RADICI PLASTICS MEXICO S. DE R.L. DE C.V.
Av. Francisco Zarco 2688
C.P. 47810 - Col. Loma Bonita - Ocotlán Jalisco – MX
Ph. +52 392 923 2390
e-mail: info.plastics@radicigroup.com

March/2020/Eng/CAE SERVICE