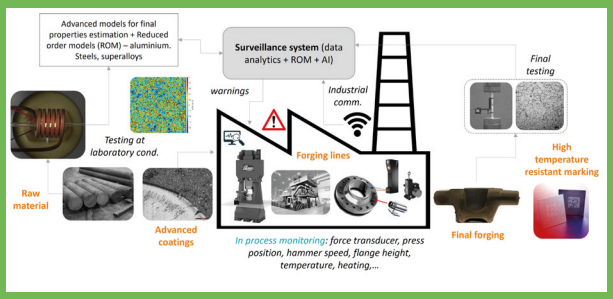
OPTFORGE, Improved hot forging processes by advanced numerical models for final properties prediction, the development of new tooling coatings and the application of AI in forging workshops

Abstract:

The hot forging industry is vital for Europe, yet recent shocks—the Ukrainian war, Covid-19, and the shift from combustion engines to EVs—have left forgers in a critical situation. Energy and raw materials are costlier than ever, and the competitiveness of established companies is at risk. In this context, OPTFORGE aims to boost OEE in European forging firms by creating advanced property-prediction models, developing novel tool coatings, implementing digital solutions, and embedding them in a smart surveillance system that detects and warns against unsafe or non-robust forging practices.



Countries involved

Application sectors
Automotive, Industrial components, Oil&Gas

Research and innovation domains
Advanced manufacturing processes, Sustainable manufacturing

Total cost in M€ (millions)
3.2 M€

Starting date
01/09/2024

Duration (in months)
30 months

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RATIONALE OF THE PROJECT

The COVID-19 pandemic and the Ukrainian war have tightened the global forging sector, making competitiveness more urgent than ever. Europe represents ~20% of the global market, second only to China, with 65,164 employees directly engaged. Energy, once ~10% of product cost, has risen sharply, forcing firms to renegotiate contracts, while raw material prices have also surged, particularly in Europe, eroding competitiveness.

Meanwhile, manufacturing is rapidly transforming through digital technologies. Data-driven analytics are used to detect production issues, yet adoption in forging remains limited due to the hazardous hot-forging environment. Maximizing ROI and Overall Equipment Effectiveness (OEE) is vital, especially as production shifts eastward where labor costs are lower. Digital tools can help monitor, analyse, and detect non-robust processes, enabling greener and more efficient production. In this context, OPTFORGE will increase OEE in forging lines for automotive, wind energy, and oil & gas components. The consortium will: (i) develop models to predict microstructure and mechanical properties, (ii) create coatings and heat treatments to reduce tool wear, and (iii) implement monitoring platforms merging sensor data with model estimations to build robust surveillance systems. Few initiatives exist in forging, making OPTFORGE's approach a decisive step toward digitalization and competitiveness.

TECHNOLOGICAL INNOVATION, ACHIEVEMENTS AND RESULTS

Although process monitoring and advanced control have been widely studied in other sectors, very few works focus on industrial monitoring of forging lines. The state-of-the-art review has identified technologies to be advanced in OPTFORGE to achieve intelligent forging lines for steels, aluminium, and superalloys. Available coatings and heat treatments have also been assessed to propose new solutions for tool life extension, another key objective.

The main bottlenecks hindering industrialization of autonomous surveillance and coatings are: (i) lack of robustness and simplicity in monitoring methods and predictive models, (ii) need for reliable surveillance and operator guidance systems, and (iii) limited coatings and heat treatments to resist wear and plastic deformation.

Main innovations proposed by OPTFORGE:
Predictive models – Existing: recrystallization, QFA, phenomenological. OPTFORGE: advanced full-field with AI for superalloys, improved QFA for aluminium, fast analytical models for microalloyed steels. (TRL4–5 → TRL6–7)
Monitoring – Existing: press monitoring, cold marking. OPTFORGE: robust systems for hazardous presses, hammer speed, model-based ring rolling, in-line laser dimension control, advanced ink marking for HT. (TRL3–4 → TRL6–7)
Tool coatings – Existing: nitriding, DED. OPTFORGE: new coatings for abrasive wear, surface modifications for adhesion, optimized combined treatments. (TRL3 → TRL5)

MARKET POTENTIAL

OPTFORGE targets the oil & gas, automotive, and wind energy sectors.

Oil & gas forgings must resist harsh conditions; the market may grow from $ 18 B (2024) to $27 B (2033). Key components include drill collars, valves, flanges & fitings, and pressure vessels;

Automotive forgings are projected to rise from $8.05B (2020) to $12.4B (2026), driven by EVs, lightweight vehicles, and customization. Components include suspension, steering, and drivetrain parts; TEKNOROT, ALTEKA, Bharat Forge, and ThyssenKrupp are major producers.

Wind energy forgings may grow from $3.21B (2020) to $4.43B (2025), including shafts, hubs, and gearbox parts; Europe and Asia-Pacific lead, with Ringmasters, Bifrangi, and KOVÁRNA as key players.

For marking, Rea GmbH leads Europe (~€65M/yr), with Matthews Marking, Tippl GmbH, and Alpine Metal Tech as competitors. Innovation in high-temperature inks and solutions drives competitiveness.

IMPACT POTENTIAL

The OPTFORGE project will strongly boost the competitiveness of forging companies in Europe by introducing advanced monitoring and coating solutions.

These innovations will improve productivity, efficiency, and product quality through state-of-the-art technologies.

Monitoring systems will help detect and prevent issues during forging, ensuring top quality standards. At the same time, new coating solutions will enhance tooling durability, optimizing processes and extending tool life. Overall, the project marks a breakthrough that will revolutionize the forging industry with novel, high-impact technologies.