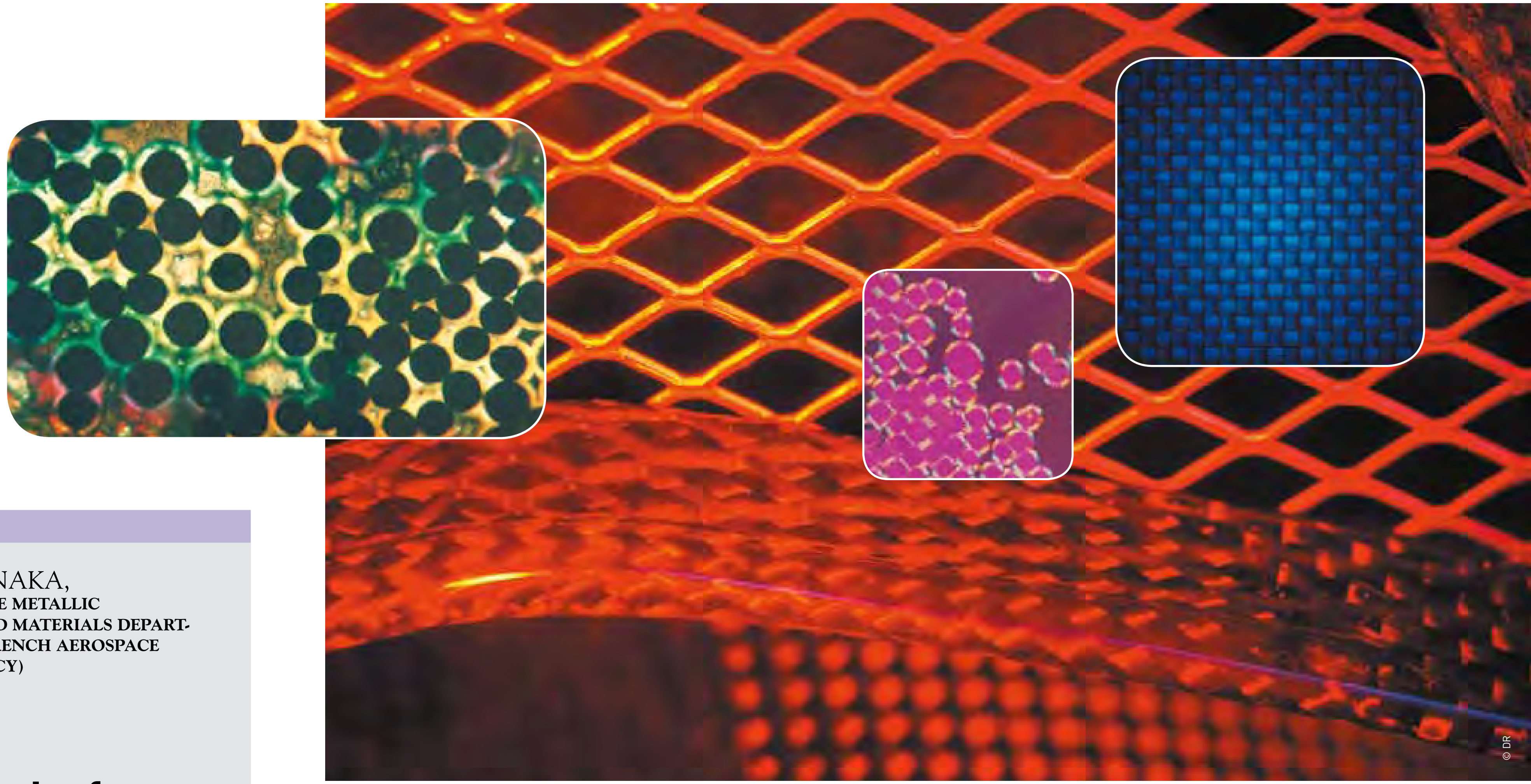
RESEARCH. Safran's researchers are studying the new materials that will go into tomorrow's aircraft engines. Stronger and lighter, these materials will help reduce fuel consumption and CO_2 emissions.

MATERIALS TO SHAPE THE FUTURE



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"For engineers working on tomorrow's engines it's a real scientific and technological challenge to strike the right balance: the continued growth of air transport will depend on the development of airplanes that are lighter, stronger and environmentally-friendlier – but don't cost any more to buy and maintain!" explains Claude Quillien, the head of materials and processes at Safran. To meet this challenge, the Group has a permanent workforce of over 750 researchers and technicians. They team up with well-known research labs, such as the Ecole des Mines de Paris engineering school, French aerospace research center Onera and national scientific research agency CNRS, to develop new materials. Their task is to find solutions that will reduce structural weight, and replace certain parts made of titanium, nickel or steel-based alloys that are used on most engines today.

Since the early 1990s the focus has been on composite materials. Made of a "framework" of carbon fibers, strengthened by an organic matrix of resin, ceramic or metal, these materials considerably reduce engine weight. "On fan blades, composites can cut weight by up to 100 or 130 kilos, with an even greater induced impact on the aircraft itself," says Bruno Dambrine, composites and materials mechanics expert.

VIEWPOINT

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SHIGEHISA NAKA,
DIRECTOR OF THE METALLIC STRUCTURES AND MATERIALS DEPARTMENT, ONERA (FRENCH AEROSPACE RESEARCH AGENCY)

"It's a heck of a challenge!"

After joining Onera in 1978, Shigehisa Naka quickly focused on research concerning new alloys. Along with his team, he worked on the development of single-crystal solidification. Since then, this revolutionary process has given rise to nickel-based superalloys that are now used to make the turbine blades on Safran engines.
In spite of all his experience, when faced with the current demands of aircraft manufacturers his immediate response is a cri du coeur, "It's a heck of a challenge!" But he's not at all discouraged, in fact far from it. Firmly convinced that metallic alloys still harbor enormous potential, he is directing his teams to focus on three main areas for the future: an intermetallic alloy based on refractory metals such as niobium, which would increase the lifespan of parts subject to temperatures reaching 1,300°C; a higher performance version of his superalloy; and an intermetallic alloy such as titanium aluminide, far lighter than the nickel-based alloy used today.

Boosting propulsion efficiency

Organic matrix composites based on polymer resins cannot stand up to temperatures exceeding 200°C, so they will be used on the "cold" parts of the engine, namely the fan blades and inlet section. Tests of these components are planned for 2010 and complete engines should be flying by 2014. These composite materials are widely used in nacelles, the structure that surrounds and protects the engine, and attaches it to the airplane via a pylon.

Ceramic matrix composites offer excellent temperature resistance – up to 1,100°C – and are therefore used on the hot parts of the engine, mainly in the nozzle and low-pressure turbine blades. They also offer excellent mechanical strength, based on a combination of silicon carbide fibers and a titanium matrix, making them the ideal material for the disks holding the blades, not to mention delivering significant weight savings.

Alloys still in pole position

Even though composites seem especially promising, Safran is also working on metallic alloys, which continue to progress by leaps and bounds. For example, a niobium/silicon-based alloy is used to make "refractory" composites that stand up to a temperature of 1,300°C. By increasing the heat-resistance of the high-pressure turbine blades, this new material will enable temperatures in the combustor to be increased, for greater engine operating efficiency.

"For the moment this alloy is still susceptible to oxidation, since we don't have an appropriate coating, and nobody knows how to produce it at reasonable cost," notes Jean-Yves Guédou, an expert in metallic materials. The first engines equipped with turbine blades using this new alloy won't fly until 2018 at the earliest. This may seem a rather distant date, but in fact for engineers it's just around the corner. For engine-makers to deploy these new materials, they have to start revamping their design tools right now by integrating the specific characteristics of these materials, as well as identifying production methods that combine robustness and cost-effectiveness. Safran's engineers will have their hands full indeed as they try to rise to these latest challenges. ■