Projektsammanfattningen ska kunna spridas och publiceras fritt och får således inte innehålla konfidentiella eller på annat sätt känsliga uppgifter. Den ska skickas in som bilaga både via Vinnovas portal och till jenny.kierkemann@swerea.se. Den strategiska betydelsen av ansökan i relation till lättviktsagendan och SIO Grafens strategi bedöms utgående från projektsammanfattningen.

Del 2. Projektsammanfattning *(max 1 sida exklusive tabeller, publik)*

Projekttitel på svenska (max 80 tecken)
Multifunktionell kompositstruktur med hjälp av Grafen

Projekttitel på engelska (max 80 tecken)
Multifunctional Composite Structures through **Graph**ene

Akronym (max 10 tecken)
MULTIGRAPH

Projektet bygger vidare på resultat från ett tidigare projekt
☐ ja, med stöd från Vinnova (Uppge projektets diarienummer: diarienummer)
☐ ja, med stöd från annan finansiär (avser offentlig finansiering), nämligen: finansiär
X nej

Projektet är
☐ i sin helhet samma projekt som har insänts till annan finansiär, nämligen: finansiär
☐ i delar samma projekt som har insänts till annan finansiär, nämligen: finansiär

Finns det uppgifter om affärs- och driftsförhållanden som skulle kunna leda till skada om de offentliggörs?
☐ ja X nej

Sammanfattning (max 1500 tecken)
Denna ska skrivas så att en extern bedömare kan förstå syftet och innehållet i projektet.

Grafen, i kombination med kolfiber och epoxi, används för att demonstrera ny funktionalitet för högt påkänd kompositstruktur i flygfarkoster. Demonstratorerna är mekaniska förband med fästelement (strukturskarvar) mellan kompositparter. Förbanden konstrueras och tillverkas för förbättrad hållfasthet, skadetålighet och elektrisk ledningsförmåga jämfört med idag använd teknik och är representativa för primära delar av flygplansskrov där 20 % viktbesparing bedöms vara möjlig. Låg vikt möjliggörs av mer effektiva förband (högre tillåtet hålkanttryck), lägre fuktupptagning och förbättrad elektrisk ledningsförmåga i laminaten, vilket minskar behovet av metall för blixtskydd och andra elektriska funktioner som skärmning och stomanslutning. Förprov med 5 och 25 µm grafenflagor dispergerade i flygkvalificerad 2-komponent epoxi har visat att processen vi använder fungerar väl m a p både tillverkning och laminatkvalitet. Grafen används i våtimpregnerad kolfiberväv med epoxi som innehåller relativt hög halt av grafenflagor och, där det ger förbättrad funktion, även kolnanorör. Våtimpregnerad väv kombineras i Saabs demonstrator med kolfiber/epoxi prepreg i laminat som dimensioneras och tillverkas enligt den modellering och simulering av hybridkompositmaterial som Chalmers bidrar med. Saab konstruerar och tillverkar laminat och förband representativa för nästa generations civila passagerarflygplan och Blackwing har motsvarande aktiviteter representativa för sportflygplan i kolfiberkomposit. Ett lågt tillåtet hålkanttryck begränsar idag kolfiberkompositens användning inom flyg

och andra branscher där sammanbyggda produkter används. Potentialen för grafen kan vara mycket stor.

Sammanfattning på engelska (max 1500 tecken)

Graphene, in combination with carbon fibers and epoxy, will be used for a demonstration of new functions for highly stressed composite airframe structures. The demonstrators are mechanical joints using fasteners (bolted joints) and composite parts. The bolted joints are designed and manufactured for improved mechanical strength, damage tolerance and electrical conductivity when compared with technical solutions used today and they are representative for primary structure where 20 % weight reduction is a realistic target. Weight saving is possible due to improved efficiency joints (improved bolt bearing strength), reduced laminate moisture absorption and improved electrical conductivity, which will reduce the current need for metals used for lightning strike protection and other electrical functions such as shielding and connectors. Tests with 5 and 25 micrometer graphene flakes dispersed in flight qualified 2 component epoxy have shown that the process we will use works well regarding both manufacturing and laminate quality. Graphene is used in epoxy for wet impregnation of carbon fiber fabric at a relatively high content. Targeted graphene volume content is above 2% by volume and where it is feasible, carbon nanotubes will also be used. In the Saab demo the impregnated fabric will be combined with carbon fiber/epoxy prepreg according to modelling and simulations to be carried out by Chalmers. The Saab design is representative of a next generation passenger aircraft and the Blackwing design represents a sport aircraft. The poor bolt bearing strength of carbon fiber epoxy composites is a limitation for aeronautic applications today and also for other markets where assembled composite structures are used. The potential for Graphene may be very big.

Startdatum	Slutdatum
2017-09-01	2019-02-28
Totalt sökt stöd (SEK)	**Total medfinansiering (SEK)**
846 938 SEK	Total projektkostnad 1 906 437 SEK

1. Projektets idé

The project goal is to use few-layer Graphene flakes as a well dispersed functional addition to carbon fiber/epoxy composite materials in demonstrators representing two aeronautical applications of bolted joints in composite primary airframes, thereby achieving a weight reduction of 20%.

2. Projektets risker och potential

If successful, the proposed project can be the first demonstration of Graphene-based improved bolt bearing strength of CFRP known to us.

Applications to be demonstrated will improve future business opportunities for Swedish companies Saab AB, Blackwing and 2D Fab AB in their respective markets. If successful, the project findings and general approach to improved composite properties through Graphene-based additions to fiber reinforced plastics can also be used by other companies in the SIO Grafen and SIO Lighter network.

The outcome of a successful project will be new, demonstrated weight-saving technologies for next generation composite airframe applications in both sport aircraft and commercial passenger aircraft markets.

Risk	Prob.	Conseq.	Mitigation
Available Graphene material has a poor quality	2	5	Screening of candidate materials will be carried out early in the project. 2DFab are able to deliver material thinner than 10 atomic layers
The effect of Graphene on CFRP bolt bearing strength is lower than expected	2	4	A combination of Graphene and aligned CNTs will be evaluated
The electrical conductivity of CFRP is lower than expected	2	4	A combination of Graphene and aligned CNTs will be evaluated
Dispersion of Graphene is too difficult	1	5	Pre-tests with good results, but the target graphene volume may have to be revised
Potential environmental health problems	1	5	The material will be handled with same level of personal protection as asbestos

3. Projektets aktörskonstellation

Saab Aeronautics will lead the project. The company has been active in the nano-engineered carbon fiber composites field well over 15 years, including carbon-based nano materials and different grades of Graphene flakes. The project leader, Linnea Selegård has a PhD in nanotechnology and a coordination role in this field at Saab. She will ensure that project results can be implemented in Saab development of industrial technologies based on Graphene.

Blackwing is a successful developer of small lightweight aircraft for both basic flight training and high G-force advanced acrobatic use. These 2-seater aircraft, designed almost exclusively out of carbon fiber composites will benefit from similar improvements from Graphene as the Saab applications. Saab and Blackwing baseline composite materials, however differ enough with respect to Graphene integration to make the two demonstrators represent alternative ways of using the added flakes.

Chalmers, department of Applied Mechanics, will focus on modelling and simulation of Graphene-enhanced CFRP laminate properties, with a focus on bolt bearing strength. Professor Ragnar Larsson is an international authority in his field and part of his work in the project will be carried out in close collaboration with UFABC in Sao Paulo. This will ensure that simulation of laminate properties are based on relevant information regarding Graphene flakes in well-defined carbon fiber composite plies.

2DFab AB will be the main source of Graphene flakes in the project. The collaboration with 2DFab in this project will allow for a tailored adjustment of flake size and flake thickness to project needs and will give a good understanding of both possibilities and limitations with this type of Graphene.

Prof Danilo Carastan at **UFABC** has collaborated with both Saab Aeronautics and Chalmers in the nanocomposites field during his visit to Chalmers for post-doc research there from March to November 2016. He has studied combinations of Graphene flakes and carbon nanotubes in combination with a flight-certified epoxy system.