

## Research Topic 25 for the ParisTech/CSC PhD Program

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:

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**Subfield:** Polymer Science/Engineering, Applied Physics

**ParisTech School:** Arts et Métiers ParisTech

**Title:** Mechanisms of instabilities in thin polymer films: effects of interfaces and confinement

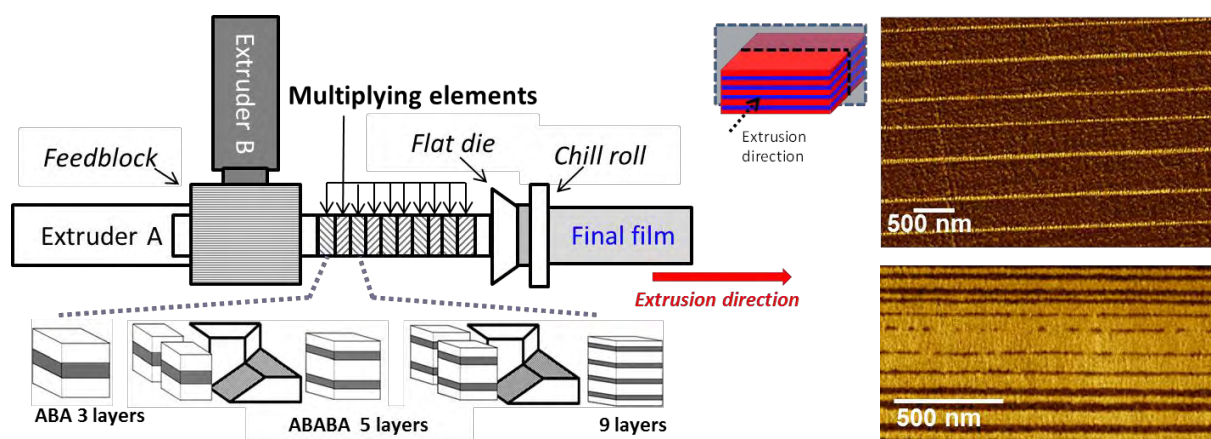
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### **Short description of possible research topics for a PhD:**

Unexpected behaviors of polymers confined at the nanometric scale (sizes similar to the radius of the macromolecules) has led to a renewed interest for the development of new technologies allowing nanostructuration of the blends.

Nanolayer coextrusion consists in forcing the polymer flows to create materials composed of thousands of alternating layers with nanometric thicknesses of different polymers. However, when brought down to this nanometric scales, instabilities can develop during the process, breaking the continuity of the layers and altering the final properties. A previous study (illustrated in figure 1, see references below by Bironeau) led to the hypothesis that these breakups were due to attractive van der Waals forces between layers of similar polymers.

The goal of this PhD will be to confirm this hypothesis and clarify the role of shear and elongation on the development of these instabilities by combining nanolayer coextrusion with model experiments. This work will be done in collaboration with colleagues from the ESPCI and Université Paris-Saclay. Arkema is also involved in the project.



**Figure 1:** schematic of the multinanolayer coextrusion process (left). PS/PMMA nanolayer films (total of 2049 layers) observed by AFM (right). In the top image, continuous layers with thicknesses on the order of 50 nm for the PMMA are observed (yellow lines). In the bottom one, PS layers (brown) below typically 30 nm are broken.

**Required background of the student:** Polymer Science or Chemical Engineering or Physics of Fluids

### **2-3 representative publications of the group:**

- Bironeau, Salez, Miquelard-Garnier, Sollogoub, *Macromolecules*, **2017**, 50, 4064
- Miquelard-Garnier, Roland, *European Polymer Journal*, **2016**, 84, 111
- Zhu, Bironeau, Restagno, Sollogoub, Miquelard-Garnier, *Polymer*, **2016**, 90, 156