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Prediction of improvement in EV electricity costs with phenolic foam insulation

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In this study, we propose electricity-energy-saving automotive parts including top-level thermal insulation materials, phenolic foam. Heating, ventilation and air-conditioning (HVAC) systems are known as huge electricity consumers for electric vehicles (EV). Thus, our proposed thermal insulation makes heat energy they generate lossless, and enhance EV electricity performance. In order to verify effectiveness of the thermal insulation, based on model based development (MBD) method with OpenModelica software package, we constructed a thermal simulation model for a whole running vehicle composed of exterior parts. In reality, phenolic foam is installable into interlayers within some of the parts (e.g. door, roof, back), and we estimated their contributions to electricity consumption of HVAC. As a result, we predicted the phenolic foam insulation enabled significant improvements in the running EV electricity costs. Our MBD model was validated with experimental data obtained by actual running tests, therefore our prediction was clarified to be quantitatively meaningful. Because phenol foam is lightweight (27kg/m^3), we considered that increase of weight had no critical influence on electricity costs.

Phenolic foam insulators are widly used as wall materials for residence and industrial facilities, because of not only their low thermal conductivity, but also light weight, large-area mass productivity, and fire resistance. These characteristics are also required for automotive exterior walls, therefore, we expect our proposal to be desirable solutions for EV's performance improvement.

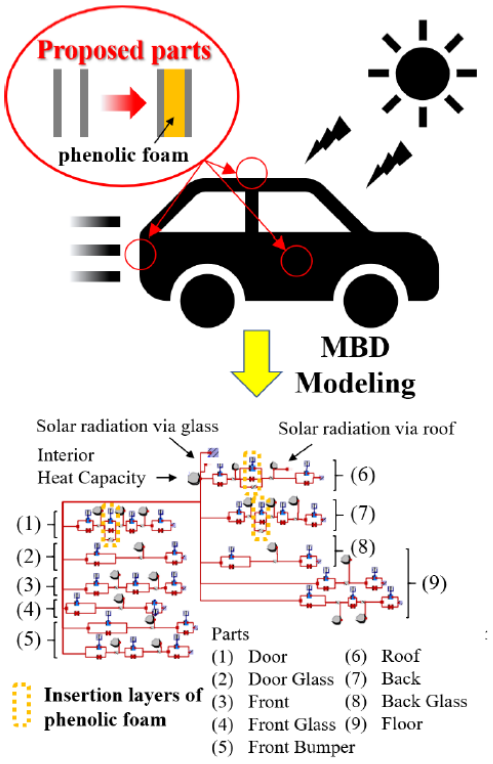

Fig1. MBD Modeling of running vehicles
(Installed parts of phenolic foam)

(a)Summer				
Phenolic foam insulation	Net heat inflow(W) (=HVAC's thermodynamic work)	Electricity consumption(W)		
		Driving	HVAC	Total
No	2043	2856	681(672)	3537
Yes	1582		527	3383
Improvement rate	**22.6%**		**22.6%**	**4.3%**
(b)Winter				
No	-1460	2856	973	3829
Yes	-998		665	3521
Improvement rate	**31.6%**		**31.6%**	**8.0%**

Table.1. Improvement rate of electricity costs
(∝ electricity consumption) for running EV vehicles
(Normal characters: simulation, Underbar characters: experiments)